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Will R. Beck

What the Hotel Guest Never Sees—or Thinks About

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MECHANICAL ENGINEERING

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1938

GEORGE A. STETSON, *Editor*

An Important Conference

A BRIEF item of news contained in the report of the February meeting of the Executive Committee of the Council, The American Society of Mechanical Engineers (page 348), is likely to be overlooked, and its significance to go uncomprehended, unless attention is called to it. The item in question refers to the decision to hold, at the time of the Society's Annual Meeting, a conference of representatives of professional divisions and technical committees, to parallel the conferences held for some years past by the group delegates of the Society's local sections.

Any device by means of which the Society's technical activities can be strengthened, coordinated, and extended is worthy of encouragement and support. The proposed conference is such a device. It will, as time goes on and experience with its operation is acquired, serve as a means of making the Society conscious of the fine body of earnest men who are on the frontier of technological development and whose function it is to provide substance to the technical programs offered at meetings and made available for engineers of this and subsequent generations in the Society's publications. Through the deliberations and leadership of such a conference, which will meet at a time when the Council is holding its most important sessions and the greatest number of members are assembled in convention, more mature and serious consideration can be directed to the important phase of the Society's life represented by the professional divisions and technical committees.

Details of the program and organization of the proposed conference have not been formulated as yet. But the Society has undoubtedly discovered a useful new mechanism by means of which increased vitality will be infused into its professional life. Properly handled, the proposed conference will mark an important point in the Society's history.

Light on Labor Problems

NO RECENT phase of American social history has created such widespread attention or has been the cause of such bitter controversy as the trade-union movement. Discussion has developed violent partisans, fierce industrial disputes, interunion wars, violent social and economic disturbances, political alignments and realignments, and a class consciousness novel and ominous in the American scene. No group of persons has been left wholly untouched; and many that have traditionally found themselves involved only as onlookers have been embroiled by reason of the fact that even the professions have been invaded by organized labor.

The engineer's most usual contact with trade unionism comes as a result of the fact that his customary rôle is that of a representative of management. Mechanical engineers particularly, because of their natural concern with industry, have habitually found their technical duties developing into administrative functions as they grow older. To the problems of management they have attempted to apply the methods of the engineering approach. Such pioneers as Taylor, Gantt, and Gilbreth, whose writings on the managerial art have enriched the literature of The American Society of Mechanical Engineers, have been followed by a vast army of men with engineering training who have borne the brunt of keeping the industrial machine functioning, and in this position, have constituted the most important link between employer and employee. Upon the skill and intelligence of these men has depended, in many cases, the success or failure of schemes of industrial administration, reasonable enough in theory, but subject to suspicion and misunderstanding in a world of human beings.

How much of the delegation of authority in applying the routine, and even the introduction, of time study, motion study, wage-payment schemes, the stretchout, and the like, has been wisely made is an open question. Certain it is that in some plants such schemes have been successful, while in others they have failed tragically, with no better explanation than is accounted for by differences in the technique of applying them. From the plan that is doomed to failure at the start because it is too complex to be easily understood and those that have been wrecked through lack of intelligence and sympathetic understanding of the other fellow's point of view, discredit has spread with distressing consequences to cases where, otherwise, no dissatisfaction would have existed. Thus has an enlightened and progressive movement suffered because of the incompetence or shortsightedness of a few who have misused it. The wide gap between workers themselves and responsible management, in which the delicate function of interpretation and understanding must be carried on by a host of foremen, clerks, and sometimes hostile supervisors, must frequently thwart the best intentions of workers and management alike.

The job is a big one, particularly under present condi-

tions, and calls for a high order of competence and understanding on the part of an executive properly empowered to carry out company policies and sufficiently in contact with all phases of personnel relations, and all levels of its administration, to be sure that plans and policies are properly put into effect. An encouraging sign of the times is the direct and personal attention which the heads of our largest industries are giving to questions involving relations with workers.

Discussion of the problems of labor relations has been a feature of recent A.S.M.E. meetings. Last month the subject was presented from the point of view of management, by H. B. Bergen. This month Merritt Lum deals with trends in wage incentives, and Spencer Miller, Jr., explains labor's attitude toward time and motion study. In the light of contemporary events, no one seeking intelligent solutions to labor problems should overlook a study of these papers.

Planning Meetings

ON THE evening of February 17 the Committee on Professional Divisions conducted a most successful series of program-making conferences in anticipation of coming national meetings of the A.S.M.E. Papers and sessions for the St. Louis, Providence, and 1938 Annual meetings were discussed and planned, and some progress was made on tentative plans for the New Orleans meeting, February, 1939, and the joint meeting, September, 1939, with the Institution of Mechanical Engineers. Thus the mechanism for planning technical programs for the Society's recently adopted policy of holding four national meetings a year is seen to be functioning satisfactorily.

Members of the Society will undoubtedly be interested in the manner in which the Committee on Professional Divisions conducted the planning conference. Representatives of the divisions and technical committee assembled at headquarters, were addressed by Crosby Field, chairman of the Committee, on the purpose of the conference, and were provided with memoranda covering the coming meetings. Adjourning to separate rooms, the representatives then carried on their preliminary discussions in groups that were composed along lines identical with the departments—basic science, power, manufacturing, and management and transportation—into which the professional divisions have been divided. A member of the committee acted as chairman of each of these groups and a secretary was available to report actions. About thirty members of the Society participated in these planning sessions. Following the group discussions, all of the representatives reassembled and the secretaries reported the number of sessions and papers planned for each of the projected meetings. As a result of the discussions, conflicts in subject matter were avoided and joint sessions of divisions scheduled.

Although the idea of a joint meeting of professional-division representatives for the purpose of setting up programs for coming meetings is not new, the impression was gained that the February conference was more fruitful than past conferences have been and that the technique employed has its merits. Members of the Society will be gratified to know that intelligent planning of coming meetings is being successfully carried on, and may be assured that no dearth of interesting papers exists.

Publicizing Tool Engineering

DETROIT was the appropriate place to hold, during the second week of March, the Machine and Tool Progress Exhibition. The automobile industry, generously represented in Detroit, is committed to annual style changes. These style changes, in addition to factors affected by production efficiency, intense competition, and volume manufacture, demand corresponding changes in tooling. Out of these practices and necessities has arisen what has virtually become an industry in itself, an industry which supplies the tools and equipment for mass-production plants. Moreover, there has also developed a profession, called by those who practice it tool engineering, which is concerned with the numerous phases of design, procurement, and economic use of machines, tools, jigs and fixtures, and auxiliary equipment necessary for mass-production manufacturing. No one should have been surprised, therefore, by the fact that the Detroit exhibition, comprising nearly two hundred exhibitors, attracted capacity crowds.

The tool exhibition was an excellent means of publicizing the work of the tool engineer. By concentrating attention on tools and equipment, the exhibition made possible a comparative and detailed study of elements that are usually only incidental to other machinery and machine-tool shows.

One came away from the Detroit exhibition with the impression that no matter how familiar or simple one of these many essential elements may be a tremendous amount of thought is being expended in improving its quality and usefulness, in making it better or cheaper, in standardizing it, or in producing it in a greater variety of forms.

Making a special detailed study of thousands of operations, any one of which can be carried out by several different methods, is the business of the tool engineer. By painstaking analysis and brilliant synthesis he keeps costs down and production up—the only sure method by which abundance can be achieved in an industrial economy. Give him the opportunity to exercise his talents and intelligence and he will lay luxuries at your feet at prices you can afford to pay.

Tool engineers are becoming sufficiently numerous and self-conscious to think of themselves in terms of a profession embracing a wide variety of functions connected with design and production. Actuated by the pride in their craft and the desire to improve it and their own economic position, they effectively called the attention of the country to their place in the mass-production industries by means of the Detroit exhibition.

It was an excellent way to publicize tool engineering.

Labor's Attitude Toward
TIME AND MOTION STUDY

By SPENCER MILLER, Jr.

WORKERS EDUCATION BUREAU OF AMERICA

ONE CENTRAL, overshadowing fact makes the consideration of labor's attitude toward time and motion study, or indeed of any problem of management, of profound importance in this year of grace 1937, and this fact is that American labor has come of age; it has reached maturity. It has won a century-old quest for complete recognition in the highest court of the land. It has achieved a measure of planned protection against some of the major hazards of industry. It has fashioned the instruments of a vast public power. Here labor stands today in our American industrial life a fact immense, inexorable, and indubitable. All those who are called upon to lead or to teach in our day must begin by recognizing this fact.

Consider if you will a few of the outstanding achievements of or participated in by labor in the last 24 months in America:

(1) Collective bargaining through representatives of labor's own choosing approved by the Supreme Court of the United States.

(2) Company-dominated systems of employee representation declared to be contrary to public policy.

(3) Espionage in labor relations repudiated by an aroused public opinion.

(4) Trade unions established in such basic industries as steel, automobile, rubber, cement, and oil.

(5) A Social Security Act providing the beginnings of a scheme of unemployment insurance and old-age pensions approved by the Supreme Court.

(6) Minimum-wage legislation by state action approved by the Supreme Court.

(7) Creation of a National Labor Relations Board with regional offices.

(8) Designation of a special representative of the American Federation of Labor on the staff of the International Labor Office at Geneva.

(9) Reaffiliation of the American Federation of Labor with the International Federation of Trade Unions.

(10) Organization of a Labor Party in the City of New York.

(11) Enrollment of more than 7,000,000 workers in the American Federation of Labor, the C.I.O., and the railroad brotherhoods, the largest number in the history of American labor and one of the largest trade-union movements in the world.

This record is not complete but it will suffice to prove my thesis that the world of labor today is not the same world into which Frederick W. Taylor first projected his ideas of shop management or when the Taylor Society was founded. It is not the same world where labor secured the adoption of a rider to the Navy and War Departments' appropriations bill preventing "a time study of any job of any employee of the U. S. Government." It is not even the same world where President Green came for the first time before the Taylor Society to invite the cooperation of management in the problem of waste elimination and increase of productivity. Ours is an age of power, an age when the mobilization of labor's economic power has for the first time achieved a parity with the power of the modern corporation in American life. Labor today not only has acquired this power but is rapidly developing a confidence in its capacity to use the power that it has developed.

Presented at a joint session of the A.S.M.E. Management Division, Society for the Advancement of Management, and the Personnel Research Foundation at the Annual Meeting, New York, N. Y., Dec. 6–10, 1937, of The American Society of Mechanical Engineers.

LABOR'S OPINION MORE IMPORTANT THAN FORMERLY

What labor thinks today, then, in this era of recovery about the application of science to industry is of vastly more importance than what labor thought in the prewar or the postwar era. For attitudes change with conditions and can be studied intelligently only in the light of the conditions that cause them to change. What far-reaching changes have been wrought in our national economy even within the last five years must be apparent to those who have eyes to see.

Certainly one of the most far-reaching changes is the transformation from an age of scarcity to an age of plenty. Frederick W. Taylor's original ideas were profoundly conditioned by the age into which they were first projected, an age of individualism, in which the economy of scarcity still held dominion in American life. Business leaders no less than statesmen, management engineers, and labor leaders were conditioned by this concept. American industry was a struggle for a division of what was produced. Both management and labor were on the defensive. The creative function of the trade union was little understood and appreciated less. H. L. Gantt, writing in his "Work, Wages, and Profits," said in 1911, "If a workman thinks it is to his interest to join a union, he has a legal right to do so; if we wish to prevent him, we must make it to his interest not to do so." Frederick W. Taylor addressed a great meeting at Philadelphia in 1914 in these words:

> There are two particular reasons why we oppose the unions—their demand for a restricted output and their demand for collective bargaining. There is not a union in the United States which does not demand these two things.

About the same time that Mr. Taylor was giving utterance to this point of view, Samuel Gompers was thundering in the legislative halls of Congress: "Labor is not a commodity nor an article of commerce. Labor is what a man is, not what a man has." In the light of history, Gompers' plea for the recognition of the human factor in industry has been vindicated. But neither Gompers nor Taylor glimpsed the vision of an age of plenty.

What labor thinks on this question is, in the next place, of vastly more importance today because it speaks from strength and not from weakness. And in the realm of human affairs, whether it be statecraft or business, he who talks from strength commands the attention of his listeners. The opposition of

unions to time and motion study in the past has arisen out of the fact that they protested many times from weakness and the fear that the possible transfer of skill would make them weaker. Out of their experience, they learned that when an employer can control the rate of payment he can virtually set the pace by selecting the fast worker and regarding him as the norm. Once, however, the worker feels confidence in the capacity of his union to protect him, his attitude is changed, his criticism turns on the method rather than the principle. One thing then is clear. Labor in the days of its power will not content itself with any mean part in the introduction of science into industry but will insist on a full and complete participation not only in the product but also in the process of such scientific advances.

To secure a clear-cut statement of labor's present attitude toward time and motion study, the author sent out a questionnaire to 30 of the leading unions of this country. The replies are significant not only for what they disclose in the way of affirmative policies but also for the absence of any declared policies in a number of cases. In these latter, the attitude of the Federation itself may be said to be the general labor attitude of these unions. This much may be said in summary:

Time study has been conducted successfully in union shops in some instances with the full consent and cooperation of the unions and the workers. In other instances the unions have opposed certain applications of time study and certain forms of wage incentives. Union labor, however, is sensitive to the harmful speeding up of workers or to the introduction of any managerial method or device that might be used in this direction. Labor, from bitter experience, feels that it has reason to be suspicious of the piecework system of wage payment. This suspicion, a heritage from unscientific rate setting and sweatshop days, readily attaches to any innovation in the development of piecework rates, even if it be scientific and actually designed to correct the exploitation that labor fears. Time study is thus regarded among some unions, doubtless with some injustice, as just another adjunct to forcing the last ounce of effort out of workers at the smallest possible cost in wages.

The most insistent objection by a majority of the unions to the use of time study is thus concerned more with the method than with the principle. Time study should be a scientific method of measuring human effort and productivity in terms of time. In many instances, however, time-study methods and their results have been imposed arbitrarily on workers by management, with little regard either to the consent of the worker or the right of joint review. Also little recognition has been given to the fact that it is the worker's job and health, indeed his very life, that will be affected. For this reason, he should be consulted and protected in his relation to changes. While the principle of joint conference and mutual consent in such procedure is a comparatively recent development, it can no longer be ignored today by either group. The importance of such a procedure has been abundantly proved. In those cases where time study has been conducted most successfully in union shops, the time-study method and its objectives have been carefully explained to the union and the workers in advance, and both consent and cooperation have been secured from labor as a result of conference and discussion. It may not be inappropriate for me to remind the members of the Society for the Advancement of Management and The American Society of Mechanical Engineers that when Robert Valentine, 20 years ago, first ventured his criticism that the scientific management of that day left out of consideration the element of consent of the worker, he was a "voice crying in the wilderness." Yet his recommendation came to be regarded as a necessary condition of its success. But today, we must take a step beyond Valentine's vision. As he foreshadowed the transformation of industry from the doctrine of compulsion to the doctrine of consent, so today we must foreshadow the new discipline of copartnership not in control of industry but in the assumption of managerial responsibility.

MANAGEMENT'S COOPERATION IN IMPROVING PRODUCTION AND ELIMINATING WASTE SOUGHT BY LABOR

But I would remind you of another declaration of labor's wage policy which is an effective refutation of those who decry the restriction of output on the part of labor. With the notable findings of the Report on Waste in Industry published in 1921, the Atlantic City Convention of the American Federation of Labor four years later formulated and adopted its productivity theory of wages in these words:

> We hold that the best interests of wage earners, as well as the whole social group, are served by increasing production in quality as well as in quantity and by high wage standards which assure sustained purchasing power to the workers and therefore higher national standards for the environment in which they live and the means to enjoy cultural opportunities.

Since that historic declaration, the American Federation of Labor has consistently sought opportunities of cooperating with management, in the improvement of production and elimination of waste in union shops. It has encouraged the organization of numerous joint conferences on waste elimination by the Workers Education Bureau of America, in which representatives of management, labor, and industrial engineers have participated, and has given the widest publicity to the results of these conferences. The American Federation of Labor, finally, maintained for a period its own industrial and management engineering service to assist industry in the development of union-management cooperation for the elimination of every sort of waste in production. This record, extending over the last 12 years, should further disprove effectually the belief that the Federation is fostering a policy of output restriction.

Time study, moreover, is a scientific method of measuring human effort and productivity in terms of time. Properly conducted, its main purpose is to analyze the manner in which a job is being performed so as to detect, and if possible eliminate, any waste of time, mechanical energy, or human effort. But one cardinal fact should be remembered. Time studies of machine production can be done with scientific accuracy. Time studies of human motions, however, owing to the imponderable human factor, cannot be made with the same scientific accuracy, according to the researches of C. E. Knoeppel, a well-known efficiency engineer, and others. A contingent purpose, usually, is that of providing an accurate time and output basis for computing piecework or bonus rates, although this is not an essential objective of time study. The latter can be used with equal effectiveness for the general investigation of work, to accumulate job-analysis data, establish output capacities upon which production schedules may be based, or provide figures on labor time and cost for estimating purposes. These other important uses of time study deserve to be emphasized because there has been an incorrect tendency to regard it as a mere adjunct or aid to calculating piecework or wage-incentive rates.

It can be stated safely that time study has been used successfully in union shops for attaining every one of these objectives. In each instance, however, the development of time study has been fostered jointly by the union and management as a form of union-management cooperation, consent and cooperation

having been gained from the union in advance. The cases that follow are well-known, each of them having received wide attention and publicity. The fact that most of them are now in abeyance as a result of the depression, or for some other reason, is unimportant. Each case had its measure of success and can be regarded as an important pioneering step in the progressive development of industrial relations.

EARLY INSTANCES OF UNION-MANAGEMENT COOPERATION

The pioneer example of union-management cooperation was in the garment trades in New York City in 1916. A board of control had been organized for the dress and waist industry, for the Dress Manufacturers' Association and the International Ladies' Garment Workers' Union. Robert C. Valentine was the coordinator in matters relating to wages, hours, and working conditions in the multitude of shops in the city. At his suggestion, The Thompson & Lichtner Company, engineers, was called in by joint agreement of manufacturers and union to establish standards of production that were fair both to the manufacturers and the workers. A "test shop" was established and a large number of blouses were time studied chiefly by union officials trained by and under the supervision of the engineers.

As a result, unit times for all operations were set up and these, by proper combination, were tabulated so that they could be used to determine the time to make a blouse of any desired style and of any material. Thus, unit times were found for such elements as sort bundle of parts, place two pieces in machine ready to stitch, stitch per inch, pivot corner, turn right side out per corner, lay aside, and so on. Standard times of the elements were different for different conditions. For example, the time per inch for stitching was given a different value for each kind of stitch and for each kind of seam and different values in each for straight and curved stitching. For each of these, in turn, specific values were given for different kinds of fabric. It was found possible from these data to set standards applying to the different conditions so that for any new style of blouse, the standard time, and from this the piece price that might vary in different shops because of local conditions, could be figured in advance by a synthesis of the units that applied to the particular case.

Many cases arose for adjustment of piece prices in various shops. The engineers were then called in and figured, from their table for the particular style in question, the time that the work upon the particular blouse ought to require without undue effort on the part of the worker, and, from this, the correct piece price per dozen garments was determined. Two cases will suffice.

The union claimed that the piece price of $4.10 per dozen was too low and should be $4.20. By synthesis of the standard times, converted into piece price for this shop, the correct piece price was found to be $3.85. In another case, the piece price of $0.58 was claimed by the manufacturer to be too high. The correct rate was found to be $0.63. In one of these, the piece price was nearly 10 per cent high and, in the other, nearly 10 per cent low and in both cases directly contrary to the best opinion of the party making the claim. When the facts were presented, each party, the union in one case and the manufacturer in the other, made good the difference for the period agreed upon.

This initial experiment, in spite of the disruption in the protocol agreement caused by the untimely death of Mr. Valentine, proved two important conclusions, in the opinion of Sanford Thompson:

First, by time study it was possible to establish unit times for all operations so that the standard time to make a garment of any style and material could be figured accurately by analyzing the elements of making the garment and applying the unit times built up by time study to determine a standard time for the complete garment.

Second, on questions of fact, the manufacturers and workers found no difficulty in reaching an agreement. The problem of piece prices then resolved itself into the question of the hourly earnings it was desired to use to translate standard times into piece prices. There was no haggling on individual piece prices, since the relation between them was determined from data brought out by factual time study.

One of the earliest of these recorded cases is that of cooperation between Glass Bevelers, Mirror Workers and Cutters Local No. 528, and the Jacques Kahn Mirror Company, Inc., in New York City. This concern, at that time outstanding producers of high-quality mirrors, undertook in 1922 a complete reorganization of its management methods and power plant, retaining industrial engineers to make the necessary survey and develop the new methods. In the course of this reorganization, a production-planning department was established with cost, material-control, and order-scheduling systems as subsidiary functions. A fruitful investigation of the factory power plant also was conducted. To begin the systematic scheduling of orders through the factory, it was necessary to know in advance the output capacity of each manufacturing operation. As no reliable output figures were in existence, the only possible way of obtaining them was by time studying each manufacturing operation.

This factory was a closed union shop, and, on starting time-study investigation, Geoffrey C. Brown, the industrial engineer on the job, quickly ran into difficulties with the union, including an incipient strike. By patiently explaining the necessity of better management methods to union representatives and frankly soliciting their cooperation in taking time studies, Mr. Brown succeeded eventually in winning the union over, even to the extent of having the union steward accompany time-study observers into the shop and emphasize, on doubtful occasions, the official union approval of the investigation.

No attempt was made in this case to establish a piecework or wage-incentive system, the time studies providing data for order scheduling and cost estimating. The factory reorganization was carried to a successful conclusion and resulted in a saving of 20 per cent in manufacturing cost and 35 per cent in power-plant cost. An interesting feature is the fact that this case is one of the earliest instances on record of union-management cooperation in the development of time study.

The third case is the development of cooperation in a time-study investigation between Local No. 33 of the United Textile Workers of America and the Pequot Mills of the Naumkeag Steam Cotton Company in Salem, Mass. This manufacturer of sheeting and pillow-case cloth, in 1928, notified the Salem textile local union, to which its 2500 employees belonged, that, owing to the difficulty of competing successfully in the industry, it was imperative that a "stretch-out" or extension in the number of machines per operative be accepted by the union and its members. Union representatives, after a turbulent mass meeting of the local, submitted a counterproposal that the management's request be held in abeyance pending an investigation by an industrial engineer to ascertain whether or not other economies in manufacturing could be effected, which would render the proposed "stretch-out" unnecessary. The union, incidentally, offered to meet the cost of the consultant's survey. This counterproposal was accepted by the mill management. Upon the recommendation of Morris L. Cooke, of Philadelphia, Francis Goodell, an industrial engineer, was retained to make a survey of the situation and advise as to the best course to follow.

Mr. Cooke subsequently went to Salem and secured the

approval of the general plan by the local union. On his recommendation, also, a resident technician was appointed by the mill management. A joint-research committee and a joint-research staff, each representative of both union and management, were then created, the latter to plan and conduct time-study and other investigations, the former to pass on the results obtained and make the necessary decisions. The cooperative program was called "joint research."

Under the jurisdiction of this organization, the operations of the weave room, spinning room, and card departments and those of the cloth-inspection room were carefully time studied. As a result of the investigation, unskilled operations, like the doffing of cloth or yarn and the cleaning of equipment, were taken from the skilled weavers, spinners, and card hands and given to unskilled workers, the skilled operatives thus relieved being able to take over and operate largely increased quotas of looms, spinning frames, and card-room equipment, which were allotted to them in connection with a revised scale of piecework rates.

The economies that followed this successful venture in union-management cooperation were considerable. In a volume entitled "Union-Management Cooperation in the Stretch Out," published by The Institute of Human Relations on the Naumkeag plan, the gross annual saving garnered by the mill through joint research is reported as approximately $300,000, an amount obviating any immediate necessity for a reduction in basic wage rates.

This interesting development has been described in many papers and articles by Messrs. Cooke, Goodell, and others[1] and has been discussed before the former Taylor Society and elsewhere.

The fourth case is that between a small hosiery mill in Columbus, Ga., the Fulwear Hosiery Mills, Inc., and the Columbus local of the United Textile Workers of America. This establishment, manufacturing men's seamless half hose, was signed up as a union shop in 1931 during the American Federation of Labor's first organization campaign. The Federation, in this campaign, maintained an industrial-engineering service which was offered freely to southern employers as an aid in developing union-management cooperation for the improvement of production in southern plants. The management of the Fulwear Hosiery Mills agreed to sign a contract with the United Textile Workers of America and operate as a union hosiery mill, on condition that the A.F.ofL. engineering service would cooperate in a union label sales campaign to develop a wider market for Fulwear half hose and, in addition, would conduct a careful survey of production methods, manufacturing equipment, and factory operations, for the purpose of detecting waste and suggesting improvements.

The industrial engineer retained by the American Federation of Labor, Geoffrey C. Brown, devoted much time to this investigation, in the course of which most of the factory operations were carefully time studied and standard output figures established. In the course of his work, this engineer used time study also as an aid to checking and readjusting certain piecework rates that had been a source of difficulty between the union and the management. This investigation brought to light much waste in production and abnormally high manufacturing cost owing to antiquated management methods and obsolete, or otherwise inadequate, manufacturing equipment. In a comprehensive report to the mill management, the union recommended installation of better equipment for performing certain operations, introduction of a modern cost system, establishment of a stores inventory and material-control system, and establishment of order scheduling as an aid to the more economical routing of work through the factory.

I might cite many other cases from the men's and women's clothing trade, the boot and shoe industry, and the metal trades to support my case. The notable results of union-management cooperation with time studies under the so-called "Cleveland Plan" of the International Ladies' Garment Workers' Union have been recorded many times by members of the Taylor Society and others. I shall not repeat them again. Eight years ago, Dr. N. I. Stone gave a vivid account before the Taylor Society of similar success in the Rochester clothing market. I repeat here only his concluding words of that address:

> Today, after more than eight years of operation, scientific management as expressed in planning and dispatching of work, time studies, written specification of standards of quality, and concentration of production control through the dispatch system which relieves the foreman of a duty which formerly took most of his time and sets him free for supervision of quality for which he is best fitted, is so firmly and successfully established that its most pronounced critics both in the executives' and workers' ranks would not think of suggesting its elimination and going back to the good old days of hit and miss.

One feature of time study as it is usually conducted is regarded as unsound by organized labor and socially minded persons outside the labor movement, including some industrial engineers of my acquaintance. This objection, as before, is directed more toward the manner in which time study is usually used than against time study itself. In a large number of cases, no provision has been made for encouraging the worker to think about his own job and suggest ways in which it might be improved. This function has been transferred to a time-study observer or a planning office, the function of the worker being dehumanized to a mere following of instructions as they come from either of these sources. Unions believe that this implication in the customary use of time study is unsound, and that the worker, who is a human being, should be given every opportunity to bring all his faculties to bear upon his work and, to the limit of his intelligence and skill, participate in developing his own job.

Still another phase of the use of time study deserves mention. For a long time, some efficiency engineers maintained that collective bargaining could not play a part in the methods of production as developed by them. They held that the results they had obtained were based on scientific methods and that collective bargaining had no place in such a situation after the results had been secured. Had this point of view prevailed and had not labor demonstrated its basic fallacy, collective bargaining would have been forced out of the manufacturing industries in the opinion of many students of labor problems.

UNION-MANAGEMENT COOPERATION PROMOTES HUMAN RELATIONS

Within the last two decades, several notable examples of union-management cooperation have been reported, which have recognized not only the values to be gained from the application of scientific methods to the elimination of waste in industry but also have promoted satisfactory human relations through the cooperative help of the trade unions. I refer to two of these.

The Baltimore & Ohio plan of union-management cooperation, developed during the 1920's in the shops of the Baltimore & Ohio, Canadian National, Chicago and North Western, and other great railway systems, was an outstanding achievement in improving production by utilizing the intelligence and skill of the workers. Here, the organized shopmen submitted constructive suggestions for elimination of waste and improvement of working conditions to their local shop committees,

[1] "Labor-Management Cooperation in Methods Development," by R. C. Nyman, MECHANICAL ENGINEERING, February, 1935, pp. 73–77.

many thousands of these suggestions being adopted and placed in operation by each of the railroads operating under the plan. The late Sir Henry Thornton, former president of the Canadian National Railway System, in an address before the 1929 convention of the American Federation of Labor, submitted the following as the major objectives when union-management cooperation was inaugurated five years earlier on the railway system of which he was head:

1 Continuity of employment.
2 A more kindly and satisfactory relationship between the railway on the one hand and its shop employees on the other.
3 An improvement in output with reduced unit costs.
4 The introduction into shop administration of the brains of the workers.
5 A more accurate conception on each side of the other's point of view.

Reviewing, later in his address, the results obtained from this new "partnership" as he termed it, President Thornton made the following interesting statement:

> After a few years of trial I assert as far as the railway is concerned and I think those who represent our men would speak similarly, that all of these results have been measurably achieved, and certainly the results have been well worth the effort.

For many of the unions, particularly on the railroads, the B. & O. plan still remains the yardstick by which to measure labor's attitude toward scientific management. Said the president of one international union, to whose union leadership this whole program owes most:

> The International Association of Machinists is a progressive, wide-awake labor organization, consisting of a highly literate and intelligent membership. Our membership will not stand in the way of human progress or industrial efficiency. However, they will not accept every system of industrial management that claims for itself the virtues of promoting progress or efficiency as being in the social interest. The mere fact that some one designates an industrial policy as scientific, does not make it meritorious or successful. We always ask, scientific—for what purpose? in whose interest? to what end?
>
> Many apostles of "scientific management," who have introduced systems intended to stimulate workers to produce more goods, have concerned themselves little or not at all with the effects of these systems on the worker, either physically, as to the effects on his health; or economically, as to the effects on the security and stability of his job; or socially, as to the effects on his ability to be a responsible member of a family and a useful citizen.
>
> In the experience of the International Association of Machinists with so-called systems of "scientific management," we have found many that were far from scientific. Frequently, the men, who held stop watches and set the task for experienced and skilled workers, were merely newly graduated college students who had never had a job in industry before, and the engineer hired to install this system, frequently, was completely ignorant of the industry or the plant whose processes he was to place on a scientific basis.
>
> The term "scientific management" has been used many times to disguise aims of employers to introduce unreasonable and detrimental speed-up systems. In other cases so-called plans of "scientific management" were sold to employers on the argument that it would lure men from their unions by an appeal to their desire to get ahead of their fellow employees.
>
> From a social viewpoint, to be truly scientific, even if only in connection with the efficiency of the worker, we need to know more than what a spurter can do in a dash. We need to know what a worker can do week after week, month after month, year after year, for his working lifetime. To be truly scientific from the viewpoint of our economic welfare as a Nation, we have to know considerable about fields of knowledge which most advocates of "scientific management" disregard entirely.
>
> Providing jobs for our nine million unemployed in productive work would create more goods and services than could any plan of "scientific management" directed toward increasing the efficiency of workers who now have jobs.
>
> The International Association of Machinists, as an organization, supports the idea of applying scientific method toward the end of achieving greater industrial efficiency, greater production of useful goods and services, and greater welfare for the Nation as a whole.
>
> The organization has cooperated with management and will continue to cooperate with management to promote efficiency, eliminate waste, and increase production, wherever the management is willing to recognize that the worker has a right to require safeguards in order to prevent detrimental effects to his health, job, and stability of employment, and to share in the increased productivity which his cooperation has produced.
>
> Generally, the advocates of "scientific management" place human welfare in a position of secondary importance. Where they suggested policies for the fair treatment of the employees, these suggestions were always incidental to the results on production. Men are to be well-treated for the same reason that a scientific farmer takes good care of his stock. This stock breeder's conception of welfare is offensive to American workingmen, and one (to the lasting credit of the worker) which encourages indignation and opposition to the so-called systems of "scientific management" which further such attitudes.

Many of you doubtless are familiar with the interesting results obtained by Robert B. Wolf through the development and application of nonfinancial incentives in the pulp and paper industry.[2] This successful experiment demonstrates the importance of vitalizing the worker's interest in his job.

Mr. Wolf's idea seems to have grown out of his conviction that industry to progress must provide every worker with an opportunity for creative self-expression and the exercise of intelligence in the work performed. As Mr. Wolf expressed it in one of his papers, "Work which does not call for thought, and which uses only muscular effort, tends to draw man down to the brute level and make for industrial irresponsibility and social deterioration." To offset this ill effect, he posted comparative charts and records indicating the progress of each operation. This information was posted throughout the plant and emphasized the quality of work performed. The cost of doing the work was shown wherever it had significance. Quantity of output was not emphasized for it was found that the removal of factors affecting quality at the same time overcame the obstacles to increased output.

Mr. Wolf's plan presupposed the application of scientific methods to production problems and close cooperation between management and unions to attain a high measure of efficiency in operation and waste elimination. Today, more and more, Mr. Wolf's far vision is being recognized. His notable success in securing union-management agreement in the pulp and paper industry is an achievement of his lifetime devotion to these sound principles of joint labor relations.

HOW LABOR REGARDS THE BEDAUX-POINT PREMIUM PLAN

Earlier reference was made to the fact that organized labor is opposed to certain well-known systems which utilize time study as an aid to the establishment of wage-incentive rates. Most notable of the systems just referred to is the Bedaux-point premium plan, and it seems timely, in view of the publicity which this system has been receiving recently, that labor's general attitude be set forth. Incorrect statements have been made to the effect that recent criticism of the Bedaux plan voiced by officers of the American Federation of Labor was based on insufficient investigation. This criticism on the part of the A.F.ofL. was based partly on the experience of its worker members in many establishments actually operat-

[2] "Non-Financial Incentives," by R. B. Wolf, Trans. A.S.M.E., vol. 40, 1918, pp. 925–946.

ing with the Bedaux system and partly on a careful investigation conducted some years ago by a management engineer, Geoffrey C. Brown, employed by the Federation. Mr. Brown in his report explained the technique of the Bedaux plan in detail and then criticized it as tending toward the harmful speeding up of workers. The following excerpt is taken from this report:

> As a result of the necessity that the Bedaux engineer is under to make a speedy showing by reducing labor cost, and also sometimes on account of his inexperience in the work, many of the standard times as set are inadequate. The phrase "tight standards" is a familiar one in plants where the plan has been or is being introduced. Then follows an interval perhaps extending over weeks or months during which the worker strives under tension and strain to attain the standard and earn a premium. During this period, he is protesting volubly against the tightness of the standard. Finally, pressed by complaints from workmen and department foremen, the Bedaux engineers investigate and the operation is perhaps given a higher "B" standard. . . Before relief comes (if it does come) the worker has gone through a period of unfair and harmful tension, mental and physical.

Another point in Mr. Brown's criticism is as follows:

> Much emphasis is placed by the Bedaux Company on the fact that as the workers are guaranteed their basic earnings irrespective of productive performance, they are thus under no necessity to "speed up" if disinclined to do so. This claim becomes meaningless when faced with the fact that foremen and overseers are paid a premium (deducted from the total premium earned by all the workers) for successfully urging workers to surpass a normal pace of 60 B's per hour. If a worker habitually fails to attain a 60-B hour, he will first be warned and finally transferred to other work or dismissed. . . ."

Further on in the report is found the following:

> An increase in the proportion of scrap or spoiled work usually follows the installation of this plan. In establishments where the craftsmanship factor is high, and where quality of workmanship is of first importance, this aspect becomes very serious. Workers on Bedaux, straining at high speed to earn premiums, almost invariably sacrifice quality of workmanship. The result is higher volume of spoiled material.

The foregoing, and the fact that the Bedaux system is imposed on labor arbitrarily by management, the principle of joint review and consent by labor being wholly neglected; and finally the fact that the system aims at a reduction in total cost, solely by a reduction in labor cost to the exclusion usually of other possible economies in material or overhead, will serve perhaps to clarify labor's present attitude toward the Bedaux system and explain its recent criticism.

It should be emphasized at this point that total manufacturing cost frequently can be reduced and substantial economies achieved without speeding up the working force. An industrial engineer informed me recently that, in his opinion, management had been, and still is, too prone to take the desired savings exclusively "out of the hides of labor," to the neglect of other obvious wastes in managerial or production methods. Valuable materials and supplies possibly are unwisely purchased and carelessly stored, and moved to their points of use. Machines may be standing idle for considerable portions of the day, owing to irregular material supply. Often the layout of departments, machines, or workbenches can be changed so as to give better routing of materials or component parts through production. Machine tools and other equipment may not be of the best type or design. Steam and electric power perhaps are being purchased or produced extravagantly or utilized wastefully. Manufacturing costs, as intimated, usually can be reduced by an investigation of these and other factors in production, and labor feels that such investigation is part of the function of good management. The easier method of realizing economies by "speeding up" or "stretching out" the workers to the exclusion of these other important factors in production is pursued too often, and the unions feel that such procedure is unfair to labor.

WHAT, THEN, IS THE SUM OF THE MATTER?

Labor's attitude on time and motion study, indeed on the whole question of scientific management, has changed. President Green himself observed a dozen years ago that labor's ideas concerning management have changed. He said:

> Many of our older concepts are giving way to the newer and more progressive points of view. The relationship of management to labor is changed and is changing. The mental attitude of labor toward industry and industrial processes is undergoing revision and readjustment. Management is understanding more and more that economies in production can be brought about through the cooperation of labor and the establishment of high standards rather than through the autocratic control and exploitation of labor. Labor is understanding more and more that high wages and tolerable conditions of employment can be brought about through excellence in service, the promotion of efficiency, and the elimination of waste.

Labor's attitude has changed because it stands today at the plenitude of its economic power; it speaks from strength, not weakness. It is needless to add that it will not suffer willingly the use of so-called scientific management as a cloak of exploitation or the disregard of the health of the worker. It can not only protect the worker and police collective agreements but it also has a vital creative contribution to make to the scientific organization of business.

Labor, furthermore, stands foursquare for increasing the national wealth and not curtailing it; it will cooperate with management under collective agreement not only in waste elimination but also in enhancing the capacity of industry to produce more goods and services for the welfare of the community. Labor is not opposed to payment by performance; it puts no premium on inefficiency. It views with deep interest discussions looking toward optimum productivity in industry, such as are contemplated at the Oxford Management Conference next spring. In a message from President Green which has just been received, we have further evidence of this fact. The telegram reads:

> Federation holds increased output at low unit costs essential to higher standards of living and that organized workers who have established collective bargaining and joint machinery for making it effective are in a position to cooperate with management to this end. Interests of labor and management are interdependent not identical. Collective bargaining is foundation upon which labor can establish its rights and responsibilities. AFL recognizes that management is responsible for deciding work orders but we believe these orders can best be written after consultation with unions of workers so as to benefit by work experience of those who handle machinery and materials. Labor is willing to cooperate with management for more efficient production if it can do so without victimization. Labor objects to time and motion studies as a speed-up device but the union is willing to cooperate with management in using them as a method of developing production policies.

Labor today, moreover, is assuming a larger measure of responsibility for the whole enterprise of industrial life. It is taking no insular view of its functions; it is not willing to accept the kind of parochialism which has too long characterized the views of some business leaders. Our economy is national, our outlook must correspondingly become national, and our organizations of labor must be equipped to function on a national basis. The older and more powerful unions

(*Continued on page 338*)

CENTRIFUGAL PUMPS *for the* COLORADO RIVER AQUEDUCT

By ROBERT L. DAUGHERTY

CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CALIF.

THE Colorado River Aqueduct is being constructed by the Metropolitan Water District of Southern California to bring water at the rate of 1600 cfs or 720,000 gpm a distance of 300 miles from the Colorado River to Los Angeles and neighboring cities. To cross the intervening mountain range, this water must be lifted a total height of about 1634 ft, thus requiring about 330,000 hp, which makes it so far the biggest pumping project in the world. Five pumping plants, with lifts ranging from 146 ft for the lowest-head plant to 444 ft for the highest, will be constructed at suitable locations along the aqueduct. These values include pipe friction in the discharge lines and vary somewhat with changing water levels in the reservoirs at the intakes for each plant.

In each plant, nine pumps, including one spare unit, will eventually be installed, so that each individual pump will have a capacity of 200 cfs or 90,000 gpm. For the lowest lift, each pump will be driven by a 4380-hp electric motor, while, for the highest lift, the motors will be of 12,500 hp each. In the other three plants, the values will be intermediate between these extremes.

The cost of the complete pumping plants, including buildings and machinery, was originally estimated to be about $12,000,000; while the cost of electric energy for pumping, even though purchased at a favorable rate from Boulder Dam, will be nearly $4,000,000 per year. Because of the large expenditures involved both in first cost and in operation, it was essential that the Metropolitan Water District secure the best and most suitable pumps for the purpose. Since, when the aqueduct is operated at its maximum capacity, a variation of 1 per cent in pump efficiency will make a difference in the operating cost of nearly $40,000 per year, an inefficient pump would prove expensive, even if it were presented to the District as a gift. High efficiency is thus of great value.

MAGNITUDE AND COST OF PROJECT WARRANT LABORATORY TESTS

Little precedent could be followed in the selection and design of pumps for this capacity and head, and leading pump manufacturers differed markedly in their opinions as to what was best. Because of the magnitude of the project and the large sums of money involved, the engineers of the District decided that a laboratory investigation was warranted. For this purpose a special hydraulic-machinery laboratory was installed at the California Institute of Technology designed and operated under the direction of Profs. Theodor von Kármán, Robert L. Daugherty, and Robert T. Knapp, of the Institute, while the Metropolitan Water District was represented by J. M. Gaylord, chief electrical engineer, and R. M. Peabody, senior mechanical engineer. This laboratory and some of the special investigations that have been made there have been described in previous papers presented to The American Society of Mechanical Engineers.[1] It has several noteworthy features, among which are the high degree of accuracy obtained in all measurements, the rapidity with which a series of tests can be run, and the wide range of pump speeds and intake pressures that are obtainable. For instance, the latter can be varied from a vacuum of 25 in. of mercury to a positive pressure of 50 lb per sq in. gage.

Among the questions to which the engineers of the District desired answers before proceeding to formulate specifications were the following: (*a*) should the pumps be single or double suction, (*b*) should single-stage or two-stage pumps be used for the higher-head plants, (*c*) what should be the proper rotative speed to be used in each plant, (*d*) what should be the minimum intake pressure for the different pumps, (*e*) what will be the behavior of the pumps when the power is suddenly shut off either by accident or otherwise, (*f*) what control equipment is necessary, (*g*) what efficiency might be expected, and (*h*) can any changes be made in present designs to improve existing efficiencies? Answers to these various questions had considerable to do with the first cost of the pumping plants as a whole in addition to affecting the costs of the pumping units themselves. Also, they affected the efficiency attainable and, thus, had a bearing upon the operating cost.

LABORATORY PROGRAM OF TESTS AND PERFORMANCE ANALYSES

The first part of the program in the laboratory involved testing and analyzing the performances of a series of pumps of different types to assist the engineers of the District in formulating the final specifications. Previous to this work, the engineers of the District had drawn up tentative plans for pumping plants and pumps as the result of their conclusions from the various opinions received from pump manufacturers. As a result of the laboratory investigations, however, many changes were made in the final specifications to reduce first cost and also secure better performance. It is gratifying to observe that all of these changes were made with the approval of the engineers of the pump manufacturers after they had had an opportunity to review some of the findings of the laboratory. Thus, no difference of opinion was found between the engineers of the manufacturers and those of the District over the specifications.

The second part of the laboratory work involved testing model pumps submitted by bidders. To qualify, each bidder had to submit a model of the pump for the highest-head plant on which he bid, and these models had to meet specified conditions of head, capacity, and efficiency within narrow limits. The purpose of this was to eliminate incompetent, inexperi-

Contributed by the Hydraulic Division and presented at the Spring Meeting, Los Angeles, Calif., Mar. 23–25, 1938, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[1] "The Hydraulic-Machinery Laboratory at the California Institute of Technology," by R. T. Knapp, Trans. A.S.M.E., vol. 58, 1936, paper HYD-58-5, pp. 663–676; also "Experimental Determinations of the Flow Characteristics in the Volutes of Centrifugal Pumps," by R. C. Binder and R. T. Knapp, Trans. A.S.M.E., vol. 58, 1936, paper HYD-58-4, pp. 649–661; and "Complete Characteristics of Centrifugal Pumps and Their Use in the Prediction of Transient Behavior," by R. T. Knapp, Trans. A.S.M.E., vol. 59, 1937, paper HYD-59-11, pp. 683–689.

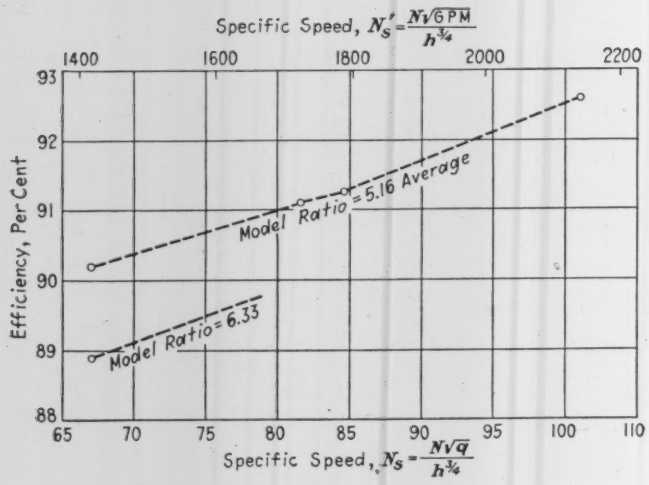

FIG. 1 EFFICIENCIES OF CONTRACTORS' MODELS OF PUMPS FOR THE COLORADO RIVER AQUEDUCT

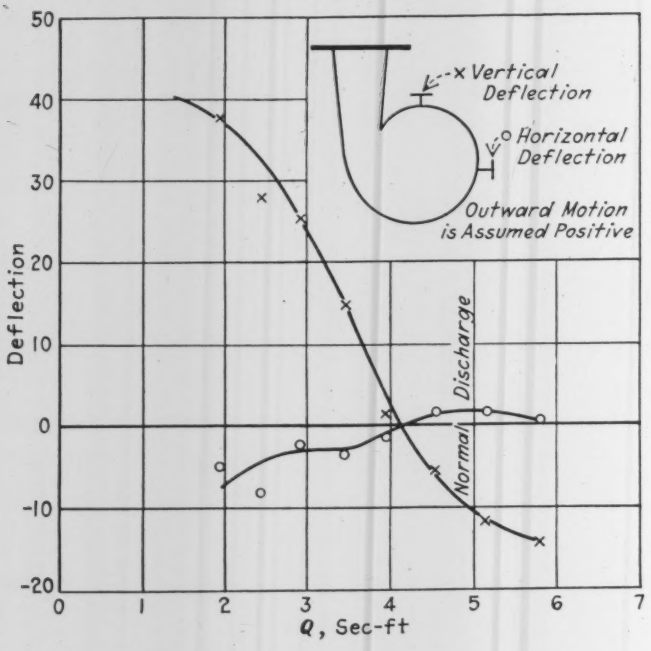

FIG. 2 HORIZONTAL AND VERTICAL DEFLECTIONS OF IMPELLER SHAFT AS FUNCTIONS OF RATE OF FLOW THROUGH THE IMPELLER

(Deflections given are in 1/1000 in. rpm, 2850.)

enced, or irresponsible bidders. If a bidder failed to meet the specifications with his model, a reasonable assumption was that he would also fail with the full-size pumps. Not only was the District interested in a pump of as high an efficiency as possible, but also it was equally important that the pump should deliver the exact quantity of water required at the head under which it would have to operate, otherwise the capacity of one plant might differ from that of another. Since the five plants are really in series, they must all operate at about the same rate even though equalizing reservoirs are located between each of them. To have to reject or reconstruct a pump after installation would be too expensive a matter and, hence, the possibility is to be avoided.

Bidders' models were required to be constructed with a scale ratio of 6.33; that is, the linear dimensions of the full-size pump were to be 6.33 times the corresponding dimensions of the model. Consequently, the capacity of the models would be 1/40 that of the prototypes. Furthermore, the model pumps were to be operated at rotative speeds that were 6.33 times those of the full-size pumps so that all the linear velocities and, consequently, the heads developed would be identical in the two cases. Thus, the power required to operate the model pumps would be 1/40 of that needed by the aqueduct pumps.

Since all the bidders submitted bids on all five plants, they all submitted models for the 444-ft lift. The three successful bidders submitted pumps, whose characteristics were similar, although not identical, and the average of the maximum efficiencies obtained by each one was 88.9 per cent. Specific speed corresponding to this maximum-efficiency point, shown in Fig. 1, averaged for the three, was 67.1 on the cubic-foot-per-second basis or 1420 on the gallons-per-minute basis.

Contracts for the construction of pumps were awarded to the

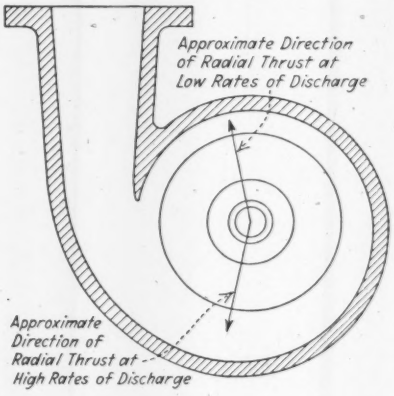
Approximate Direction of Radial Thrust at Low Rates of Discharge
Approximate Direction of Radial Thrust at High Rates of Discharge

FIG. 3 CHANGE IN DIRECTION OF RESULTANT RADIAL THRUST WITH CHANGE IN RATE OF FLOW

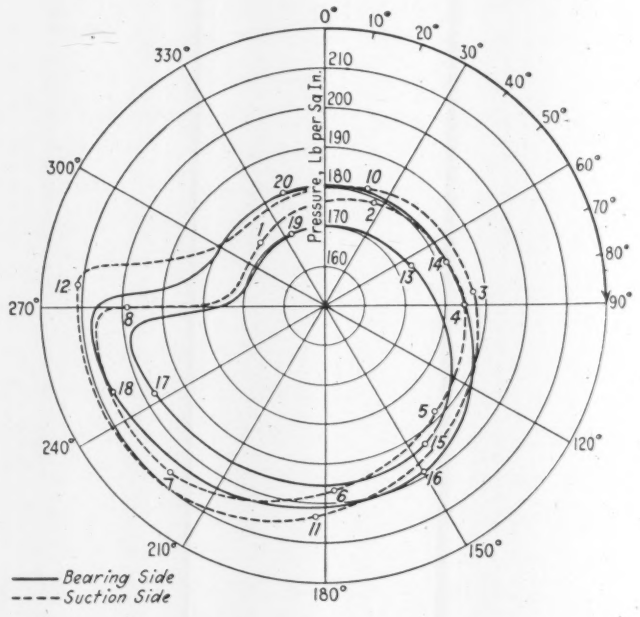

FIG. 4 PRESSURE MEASUREMENTS AROUND THE CIRCUMFERENCE OF THE IMPELLER SHAFT WITH + 37 FT TOTAL INLET HEAD—LOOKING INTO IMPELLER EYE

(These measurements, which were taken for a flow of approximately 20 per cent of normal discharge rate, confirm change in direction of resultant radial thrust shown in Fig. 3. Outer pair of curves show pressures at radius of impeller and inner pair at 0.85 impeller radius.)

Worthington Pump and Machinery Corporation for the 444- and 440-ft lifts, to the Byron Jackson Company and The Pelton Water Wheel Co. jointly for the 310- and 294-ft lifts, and to the Allis-Chalmers Manufacturing Company for the 146-ft lift.

The next phase in the operation of the laboratory was to test the models submitted by each contractor for the actual plant for which he secured the contract. The purpose of these tests was first to see if the operation of the model was satisfactory in every way for the conditions of service in that particular plant and also if the contractor could utilize the results to improve his pump in any way.

MAXIMUM-EFFICIENCY, RADIAL-LOAD, AND CAVITATION TESTS

The maximum efficiencies secured with these contractors' models are shown in Fig. 1. In each case, the head and capacity at which the absolute maximum efficiency was obtained were used for computing the specific speed. Although this point of maximum efficiency was within the specified range in each case, it did not always coincide with the exact head and capacity for which the pump was nominally designed. It is seen that gratifyingly high efficiencies were obtained. This figure is of interest in showing the variation of efficiency with specific speed for a series of pumps of the same capacity and of the same quality of construction. It might be noted, however, that one need not expect the efficiency to increase continually with further increase in specific speed. Probably, this is about the optimum specific-speed range and, for values materially higher than this, the efficiencies obtainable would be less.[2]

A further point of interest is the difference in efficiency of 1.3 per cent between the pumps with a model ratio of 6.33 and a larger pump with a model ratio of 5.1. These are for the same specific speed and are similar in design except for the matter of size. It will add considerable interest to this when the efficiency of the full-size pump for the same plant has been determined.

[2] "Hydraulics," by R. L. Daugherty, McGraw-Hill Book Company, Inc., New York and London, fourth edition, 1937, fig. 313.

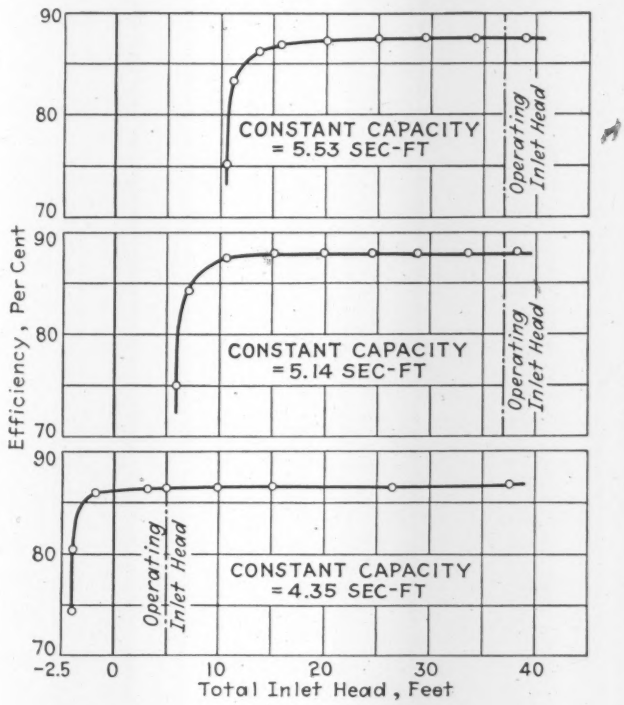

FIG. 5 DROP IN PUMP EFFICIENCY AS A FUNCTION OF THE INLET HEAD

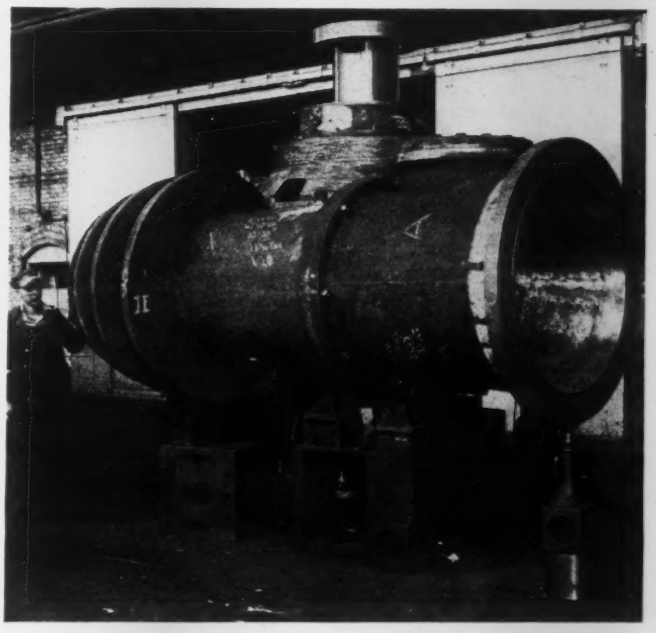

FIG. 6 CASING OF THE 90,000-GPM PUMP WHICH IS DESIGNED FOR A LIFT OF 146 FT AND A SPEED OF 300 RPM

(The diameter of the casing is 48 in. and heavy stiffening ribs are a feature of the construction.)

One of the investigations made in the laboratory was that of unbalanced radial load on the impeller shaft caused by inequality of the pressures in the volute casing surrounding the impeller. This is shown in Fig. 2, which gives the measured shaft deflection in two directions at right angles to each other as functions of the rate of flow through the impeller. The capacity for maximum efficiency was nearly 5 cfs in this instance, and, at about 83 per cent of normal capacity, the radial thrust was zero but increased to relatively high values for small rates of discharge. Fig. 3 shows the change in direction of this resultant thrust with change in the rate of flow. This observation of shaft deflections was confirmed by pressure measurements around the circumference with results typified by Fig. 4 for a flow of 20 per cent of the normal discharge rate.

This problem has been briefly mentioned in a publication[3] of the Worthington Pump and Machinery Corporation by Max Spillman, its consulting engineer, who quotes Dr. Lawaczek of Munich as having diagnosed the phenomenon. It was observed in the laboratory that pumps with stiff shafts would operate continuously with negligible wear of the clearance rings, although they were a close fit. But a pump in which the shaft was not sufficiently stiff would show rapid wear on the rings with a resultant rapid increase in the leakage loss. As a result of these studies, the District specified larger-diameter shafts than would have been the case otherwise. This is particularly important for high-head pumps, since the radial thrust increases with the speed and head of a given pump. Although the present problem has been met by shafts of adequate stiffness, other solutions are possible, such as using a double-volute case, with one volute beginning at a point 180 deg from the other, and similar schemes for securing hydraulic balance.

Because the laboratory was designed so that the inlet head

[3] "Axial and Radial Thrust in Multistage Centrifugal Pumps," by Max Spillman, Worthington Pump and Machinery Corporation, Bulletin W-318-E3A.

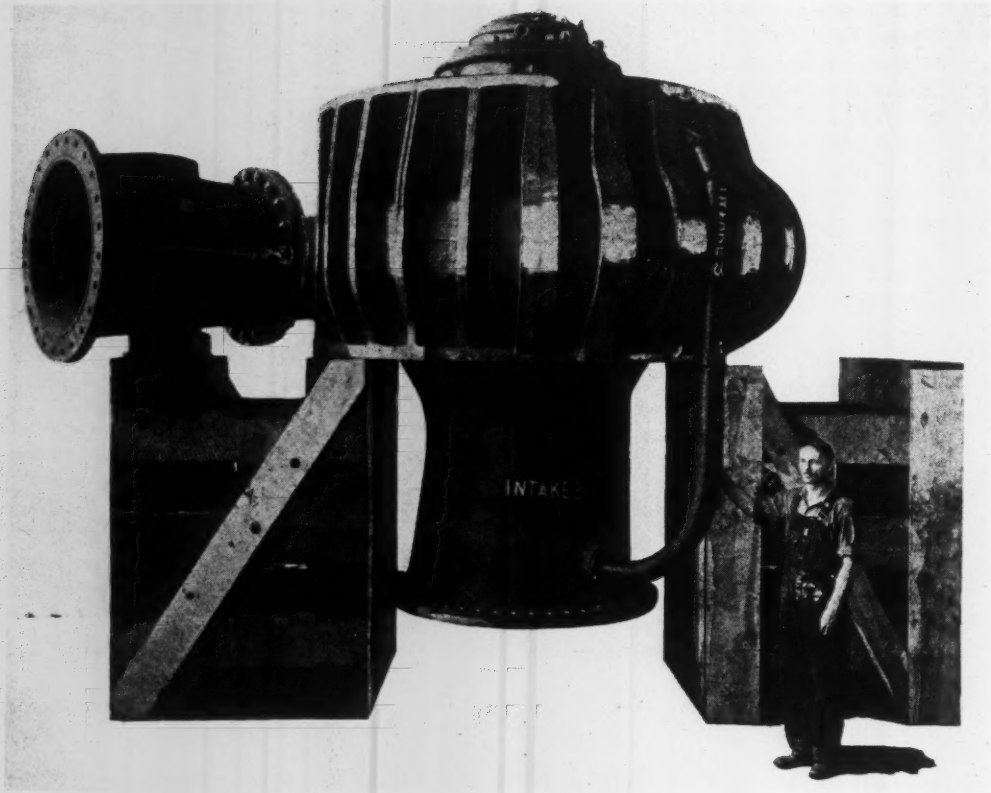

FIG. 7 PUMP DESIGNED FOR INTERMEDIATE LIFTS

on the pumps could be varied through such a wide range, it was feasible to determine the cavitation limits for all of the pumps and to see that every accepted design would operate satisfac torily under the actual installation conditions on the aqueduct. The method of doing this was to operate the pump at constant capacity and speed, while the inlet head was decreased in small steps until cavitation began. This was evidenced by abrupt drops in efficiency, head, and power input. Drop in efficiency as a function of the inlet head is shown in Fig. 5. As would be expected, cavitation begins earlier with decreasing inlet head for large flows than for smaller. The allowable inlet-pressure decrease before cavitation begins is not only a function of the flow through the pump but also depends upon the speed of the pump, and, consequently, the head developed. Also for a series of pumps of different specific speeds, the higher the specific speed, the larger must be the inlet pressure if cavitation is to be avoided. Also two pumps of the same specific speed and with other factors the same will differ in their cavitation character istics. This is due to the particular design employed and, hence, made it necessary to check this feature on every model before it was accepted. An efficient impeller was sometimes found to have bad cavitation characteristics.

Because of the large physical size of the volute cases employed and the relatively high heads under which they are all used, special features of construction were necessary. In Fig. 6 is shown the case with heavy stiffening ribs which was built by Allis-Chalmers. Figs. 7 and 8 are views of the cases built by Byron Jackson and The Pelton Water Wheel Co. Casing and impeller of a pump that was built by the Worthington Pump and Machinery Corporation for the highest lifts are shown in Figs. 9 and 10, respectively.

LABORATORY-TEST RESULTS USED AS BASIS FOR SPECIFICATIONS

As a result of the first series of laboratory tests, single-stage pumps were specified for all plants, whereas the general opinion was that the two-stage type would be better for the higher lifts at least. However, in a pump of this size, two stages would mean two separate pumps in series, which would require more complicated piping and a larger pump house, or even two entirely separate units with separate motors and switchboards, thus further increasing complexity and cost. Also, the general opinion was that double-suction pumps were better for this purpose but this was proved not to be the case. Use of a single-suction vertical-shaft pump made a much simpler and cheaper installation. Higher rotative speeds were specified than the manufacturers were originally willing to offer. This reduced the size of both pumps and motors and, hence, of the pump houses. Also, as seen in Fig. 1, this gave higher specific speeds, and better efficiencies were thus possible. Cavitation studies

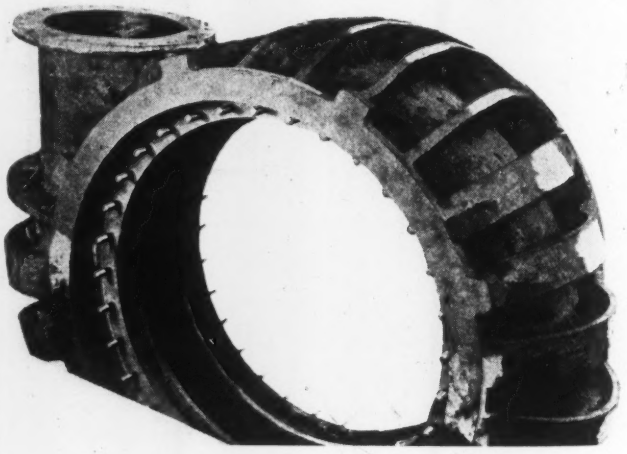

FIG. 8 ANOTHER VIEW OF THE CASING FOR THE PUMP SHOWN IN FIG. 7

established the necessary inlet pressures and, hence, determined the minimum excavation that was necessary for the pumps to be set low enough but not excessively so. On the other hand, with the inlet pressures fixed by other considerations, these studies gave assurance that the pumps would be free from cavitation troubles under the existing settings. While certain individual engineers would have proposed one or more of the features finally adopted in the specifications, the District would doubtless have been guided by the majority opinion on these various points.

Comparing the cost of the five pumping plants as finally designed with what is known would have been the case if the laboratory investigations had not been made, the engineers of the Metropolitan Water District have estimated that it will save more than $700,000 on the initial installation of three pumping units in each plant and will save more than $1,400,000 for the ultimate development with nine similar units. Since these figures do not include all of the items that are affected, the total saving is really considerably more.

While it can never be known just what efficiencies would have been obtained if these investigations had not been made, it is generally agreed that the efficiencies which will be realized will be about 3 per cent higher than would have been the case if the laboratory had not existed. This will result in an annual saving in the cost of electric power of nearly $45,000 at the start with three units operating and will rise to $120,000 per year when eight of the ultimate nine units are in service.

In addition to the foregoing tangible values, other factors cannot be expressed in dollars. Among these are freedom from cavitation troubles and other features that should tend to maintain high efficiencies as time goes on and insure longer life for the equipment with greater freedom from breakdown and repair. It seems clear that the laboratory investigation has been profitable and also that the Metropolitan Water District is obtaining pumps of as high a quality as can be produced.

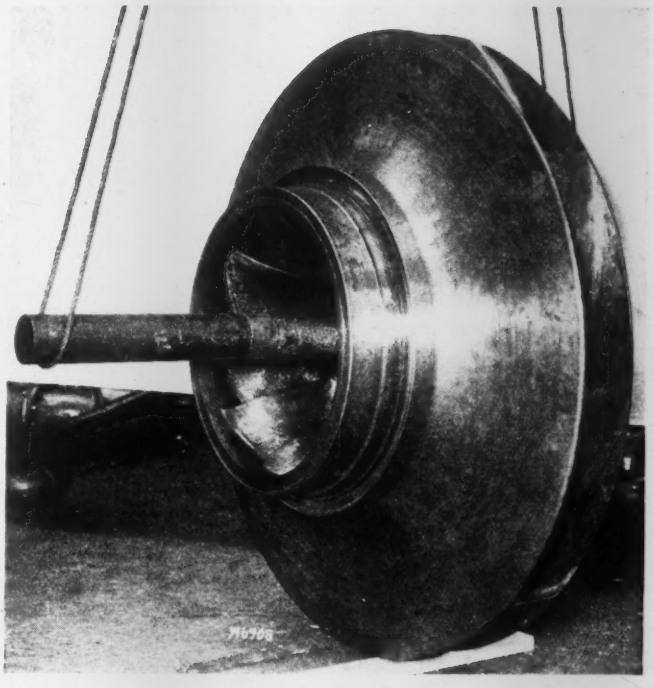

FIG. 10 IMPELLER OF THE HIGH-HEAD PUMP

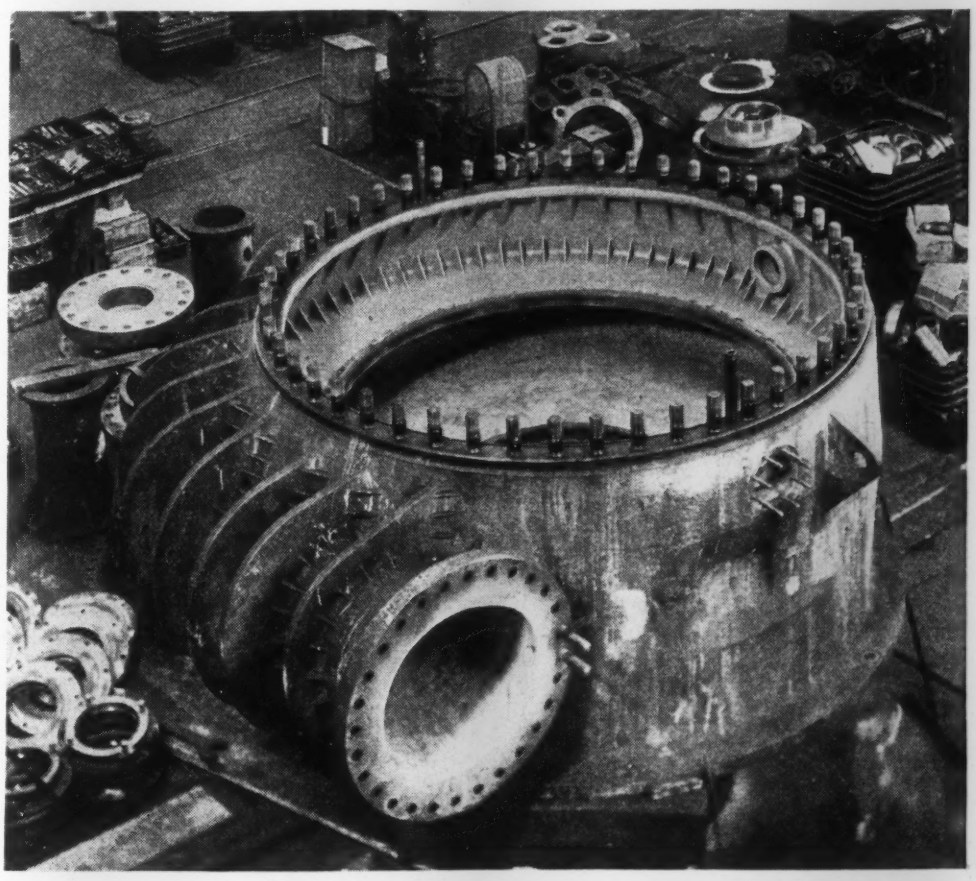

FIG. 9 CASING OF PUMP DESIGNED FOR A HEAD OF 444 FT

THE AUDIENCE BE—PLEASED!

We Don't Know How Badly We Speak

By S. MARION TUCKER

POLYTECHNIC INSTITUTE OF BROOKLYN

FEW OF US, perhaps fortunately for our self-esteem, suspect how badly we speak in public. We rarely see and hear ourselves as others see and hear us. Hardly ever has anyone the nerve to tell us what ails us. And perhaps were we told, we would not believe. Audiences in general are wonderfully patient and will suffer almost any outrage through sheer good nature. If we all pooled the results of our common suffering as auditors, not to mention the suffering that we have inflicted upon others, the ghastly display might deter any truly humane person from ever again opening his mouth in public.

Fortunately, for both speaker and audience, no one of us ever runs the entire gamut of blunders. If he were so maladroit, he would be summarily executed after his first speech as an enemy to society. But each one of us is likely to have at least one pet fault, and of this he is almost sure to be entirely unconscious.

We have all listened to the multitude of addresses and "papers" delivered at the annual conventions of our various societies, and at the business meetings and more or less convivial occasions associated therewith; we have heard hundreds of speeches on all kinds of subjects, by all kinds of speakers, under all kinds of conditions. Few of us have made any catalogue, even mental, of the faults that we were more or less conscious of in these speeches; but, if we took thought, we should discover that the major faults are, after all, fairly obvious, are not so numerous, and can easily be catalogued. A catalogue has no insinuating grace or charm, and it certainly lacks subtlety. It is frankly and coldly mechanical. But it is at least definite and precise. Where do many of us go wrong?

OUR ORDINARY FAULTS

Subject Matter. (*a*) Choice of a subject that is not suited to the audience; (*b*) failure to choose those aspects of the subject that will best suit the purpose of the speech, the audience, and the time allowed for the speech; (*c*) poor organization of the material; that is, failure to state points in a coherent, progressive order, and to provide proper transitions and connectives; and (*d*) too long a speech for the occasion.

Style. (*a*) An inadequate vocabulary; (*b*) words used inaccurately or clumsily; (*c*) incorrect grammar and pronunciation; and (*d*) cumbersome sentence structure which apes a formal and literary style, such as that of most speeches read from manuscript and virtually all "papers."

Manner of Speaking. (*a*) A weak, harsh, or otherwise unpleasing voice; (*b*) indistinct enunciation; (*c*) annoying bodily mannerisms; (*d*) failure to use illustrative material at the right time; and (*e*) misuse of the blackboard, charts and slides, and other such material, with a wrong bodily position toward the audience.

One fault that few of us ever note or, indeed, are ever conscious of, is a major fault which envelops and penetrates and explains all lesser ones, the chief fault of all; *lack of knowledge of the audience and consideration for it.* To be constantly in accord with the audience is to speak effectively. To ignore the feelings of the audience, to disregard its psychology, is, generally, to speak badly. If good public speaking be merely dialogue with only one side audible, then surely the *inaudible* side, that of the audience, must be felt and imagined by the speaker. How can he ever feel and imagine it unless he is himself actually participating in the thoughts and feelings of that other side?

THE ONE "RULE" WE MUST NOT BREAK

It has been said that there are no hard and fast rules in public speaking. This is not quite true. One hard and fast rule cannot be broken without disaster—*the audience must be satisfied.*

If a speaker knows how to handle his audience, he may break all the "rules" in the calendar. Audiences vary in their demands, and speakers vary in their devices to satisfy these demands. If a speaker has something to say that a particular audience wants to hear, he can have this, that, or the other fault and still succeed. Provided that he have something interesting to say, then about all that can absolutely and invariably be required of him is that (*a*) he have enough words to express his meaning, (*b*) his words flow readily, and (*c*) he speaks audibly. This reduces speaking to its absolute fundamentals as far as the speaker himself is concerned.

SELF-EXPRESSION VERSUS COMMUNICATION

The reason that so many speakers fail to take the audience into consideration is simple enough; they are dead-bent on expressing *themselves*, not on communicating something. There is a world of difference here. Self-expression is all right in its way, but its way is limited; it may lead little further than the lips of the speaker. He may talk to his own satisfaction, may say his say and love himself for saying it, and yet give hardly a glimmer of an idea, hardly an iota of information, to his audience. He may even be boring it or offending it with every word he utters.

Actually to communicate, to put it across, to bridge the chasm between himself and his hearers, he must really do what the word *communicate* means. He must make his audience partakers of what he says, must make common cause with it, must enter into its thoughts and feelings. He must, as far as humanly possible, make himself one with his audience. This he surely cannot do if he is thinking only about himself; if he is too complacent; if he talks to *himself* and not to his audience. He must stand on a mental and emotional level with his audience. He must not talk at it, nor even *to* it, but actually *with* it. If there be any art of communication, this is the essence of it. No speaker who tries to make himself one with his audience is likely to make a completely ineffective speech. No speaker who utterly disregards his audience is likely, except by the peculiar grace of God, to satisfy its demands. And we all know the two classes of human beings who are said to be under the special care of Providence.

Second in a series of articles on the presentation of technical papers.

UNIVERSITY OF CALIFORNIA PUMP-TESTING LABORATORY

By RICHARD G. FOLSOM

UNIVERSITY OF CALIFORNIA, BERKELEY, CALIF.

THE general research program of the hydraulic laboratory of the University of California includes an investigation of all methods of pumping. This work has been planned to study types of pumping, develop quantitative methods of predicting pump-performance characteristics, and discover or improve the basic design procedure. Although water is the fluid generally considered, the program includes studies with compressible and incompressible fluids, colloidal solutions, mixtures of small solid particles in suspension in fluids, and other substances. Results obtained to date have been published[1] and include studies on the hydraulic ram, jet pump, air lift, and propeller pump, and problems associated with centrifugal pumps, such as disk friction, hydraulic thrust, leakage, and kindred subjects.

Centrifugal pumps are the most important type commercially. For particular operating conditions, these units have reached an advanced stage of perfection with efficiencies in excess of 90 per cent being reported. In the application of these pumps, many special requirements arise which provide a profitable field for research. The new pump-testing laboratory is being developed at present to study those particular problems connected with vertical-shaft pumps of which the deep-well turbine and propeller pumps are examples.

Deep-well pumps were developed to meet the requirements of falling underground water levels in agricultural regions that depended on irrigation. Since falling water levels are a major problem in California, the manufacture of deep-well turbine pumps is an important industry of that state, and major developments of these units have been made by commercial manufacturers.

To assist the research and standardization that is of vital importance to industry and agriculture, several divisions of the University of California have combined their efforts to make the new laboratory possible. Funds were obtained from a special grant. Operation of the laboratory is under the direction of the department of mechanical engineering with the research program being worked out in cooperation with the division of agricultural engineering and the division of irrigation investigations and practice of the college of agriculture of the University and the pump manufacturers interested. Work of the laboratory will include

1 Research in the field of deep-well and propeller pumps
2 Analysis of laboratory and field methods of testing, development of test standards, and calibration of test instruments
3 Tests of motors, bearings, and other auxiliary equipment
4 Tests of manufacturers' types
5 Tests on specific pumps and pump accessories and equipment.

LABORATORY AND FIELD TESTING

In any test, results are valid only within a certain tolerance depending on the accuracy of methods applied. Even though small in research and laboratory testing, variations in performances depending on conditions and equipment appear. These conditions have been demonstrated effectively in a few isolated cases. For example, aeronautical laboratories collected data on a given model tested at different laboratories. Resulting coefficients possessed definite variations in magnitude for similar conditions. This procedure was followed by the electric-motor manufacturers with even a wider range of test characteristics. At present, the A.S.M.E. Special Research Committee on Fluid Meters is following a similar program with the long-radius nozzle. Observations of laboratories for pump testing indicate that a wide spread of pump characteristics would be expected if they were to test a single given pump, this difference being the result principally of the type of test equipment and methods of operation.

Field tests of deep-well pumps are conducted by many groups; including the power companies, pump manufacturers, owners, and farm advisers. With the wide variation in conditions of pumping and methods of testing, present American codes are not sufficiently specific to allow a satisfactory comparison of tests by different methods. The pump-testing laboratory is being developed to provide more accurate facilities for obtaining results that will serve as a basis of comparison for present methods of testing. To accomplish this aim, typical arrangements of identical equipment will be tested by field and laboratory methods simultaneously.

In view of the difficulties of field testing, present American practice regarding tolerances appears unsatisfactory in that no allowance is made for the particular test methods employed. As stated by the Hydraulic Institute,[2] "No minus tolerances or margins shall be allowed with respect to guarantees for head, capacity, or efficiency. A plus tolerance of 10 per cent shall be allowed in capacity at the specified head." The British standards are more reasonable on this point as they give,[3]

"*Tolerance on Pump Efficiency.*—The tolerance on pump efficiency shall normally be ±2.5 per cent when the discharge is determined by methods

[1] See "Leakage Loss and Axial Thrust in Centrifugal Pumps," by A. J. Stepanoff, Trans. A.S.M.E., vol. 54, 1932, paper HYD-54-5; "Propeller Pumps," by M. P. O'Brien and R. G. Folsom, Trans. A.S.M.E., vol. 57, 1935, paper HYD-57-3, pp. 197–202; "The Hydraulic Ram," by M. P. O'Brien and J. E. Gosline, University of California Publications in Engineering, vol. 3, no. 1, 1933, pp. 1–58; "The Water Jet Pump," by J. E. Gosline and M. P. O'Brien, University of California Publications in Engineering, vol. 3, no. 3, 1934, pp. 167–190; "The Transportation of Sand in Pipe Lines," by M. P. O'Brien and R. G. Folsom, University of California Publications in Engineering, vol. 3, no. 7, 1937, pp. 343–384; "Reversed Flow Through Centrifugal Pumps," by M. P. O'Brien and J. E. Gosline, *Power Plant Engineering*, February, 1934, pp. 100–102; and "Hydraulics," by J. N. Le Conte, McGraw-Hill Book Company, Inc., New York, N. Y., 1926.

Contributed by the Hydraulic Division and presented at the Spring Meeting, Los Angeles, Calif., Mar. 23–25, 1938, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] See "Standards of Hydraulic Institute," Section F—Test Code, Hydraulic Institute, New York, N. Y., 1937, p. 3.

[3] See "British Standard Specification for Pump Tests," Specification No. 599, British Standards Institution, London, 1935, p. 29.

described in clauses 12 to 25 inclusive. . . . When, however, the probable accuracy of the water discharge measurement is not within ±2.5 per cent, the tolerance to be allowed on the pump efficiency guarantees shall be not less than the probable limits of accuracy of the water quantity measurement.

Under several of the clauses noted, a statement on accuracy of discharge measurements with various types of meters is included and contains the phrase "provided that every precaution is taken." A few of these limits of accuracy are given in Table 1. These tolerances indicate the accuracy to be expected by

TABLE 1 LIMITS OF ACCURACY OF DISCHARGE MEASUREMENTS

Type of meter	Per cent
Field volumetric measurement	±1.0
V-notch weir with 3 to 15 in. head	±1.5
Fully contracted rectangular weirs with heads greater than 3 in.	±2.0
Current meter	±3-4
Venturi meter	±1.5
Nozzle	±2.0
Orifice	±2.0
Pitot tube	±2.0

the use of a quantity meter that has not been calibrated but has been manufactured, installed, and used with precaution.

In the discussion of any hydraulic machine, it is necessary to define that portion of the equipment which is the machine as distinguished from the part considered as fluid conduits. In the case of standard centrifugal pumps, the machine is usually assumed to be that portion between the pump flanges. For the deep-well turbine pump, the machine is defined as the unit between and including the strainer and the discharge elbow. For testing and investigation, it becomes necessary to separate into parts the deep-well turbine pump as defined.

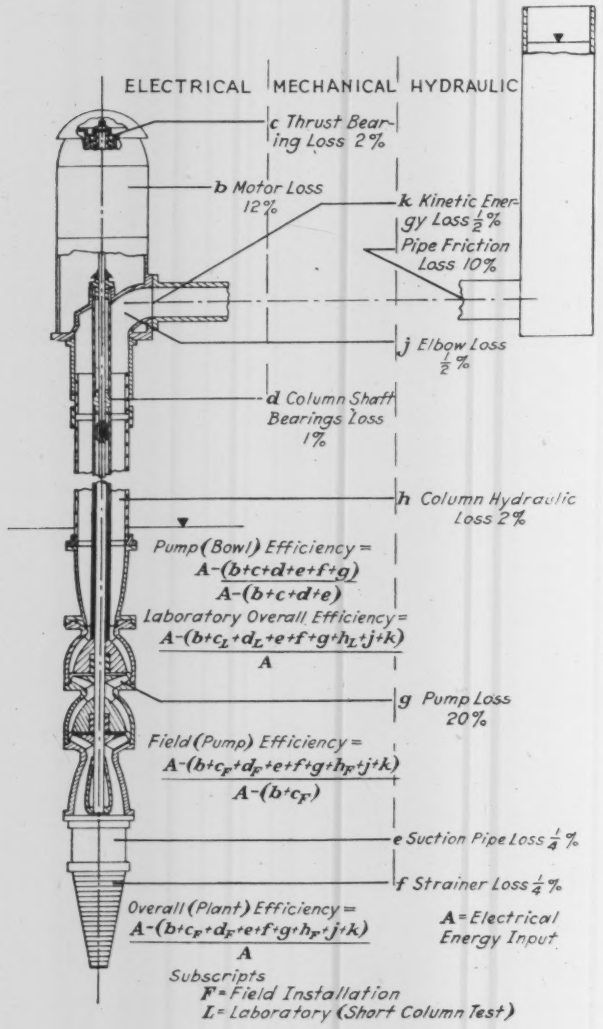
ELECTRICAL
MECHANICAL
HYDRAULIC
c Thrust Bearing Loss 2%
b Motor Loss 12%
k Kinetic Energy Loss ½%
Pipe Friction Loss 10%
j Elbow Loss ½%
d Column Shaft Bearings Loss 1%
h Column Hydraulic Loss 2%
Pump (Bowl) Efficiency = A-(b+c+d+e+f+g) / A-(b+c+d+e)
Laboratory Overall Efficiency = A-(b+cL+dL+e+f+g+hL+j+k) / A
g Pump Loss 20%
Field (Pump) Efficiency = A-(b+cF+dF+e+f+g+hF+j+k) / A-(b+cF)
e Suction Pipe Loss ¼%
f Strainer Loss ¼%
Overall (Plant) Efficiency = A-(b+cF+dF+e+f+g+hF+j+k) / A
A = Electrical Energy Input
Subscripts
F = Field Installation
L = Laboratory (Short Column Test)

FIG. 1 ENERGY LOSSES IN A DEEP-WELL TURBINE-PUMP UNIT

Fig. 1 illustrates a typical deep-well turbine-pump unit, the principal parts being strainer and suction pipe, pump bowls, riser column including drive shaft and bearings, discharge elbow, thrust bearing, and the driving unit which is illustrated as an electric motor. The usual laboratory test includes all parts, but the riser column is shortened to such an extent that the test is essentially on the pumping unit with no riser column. For specific installations, unit-test characteristics are corrected for column conditions to give the complete deep-well turbine-pump performance.

Tests are made to determine the characteristics of the pump alone independent of the driving unit. As the motor and pump are often built together—for example, with the standard hollow-shaft motor the identical thrust bearing is used for both motor and pump—it becomes a matter of definition as to allocation of losses between the pump and driving motor. The Standards of Hydraulic Institute require the total thrust-bearing loss to be charged against the motor even though this loss depends principally on the magnitude of the thrust load of the pump. The standards define the total head developed by the pump, as the difference in elevation between the water level in the suction pump under operating conditions and the center of the discharge pressure gage plus the reading of the gage. This definition arbitrarily neglects the velocity head in the discharge pipe, thus producing an efficiency slightly less than the actual. For most deep-well work, the omission of velocity head is valid; however, with low-head propeller pumps, this approximation is no longer practical.

Approximate losses, electrical, mechanical, and hydraulic, are illustrated in Fig. 1 for a typical deep-well turbine unit. For a complete analysis of the unit, each loss indicated must be measured. Electric-motor efficiency is affected by losses in the thrust bearing which are dependent on the hydraulic thrust of the motor and pump, bearing and housing design, and lubrication. Friction loss in the shaft bearings and hydraulic losses depend on the length of riser column and will vary for each arrangement of a given pump. Of all the errors involved, the greatest occur in measurements of power input to the pump and the rate of discharge. Several efficiencies of importance are indicated in Fig. 1. Those usually of interest are the pump (bowl) efficiency, laboratory over-all efficiency, and field (pump) efficiency.

DESCRIPTION OF LABORATORY

The laboratory is placed in the open in an area adjacent to the hydraulic model basin, where operation in three years has shown a loss of about one month per year of experimental time due to adverse weather. The water reservoir is an abandoned swimming pool of 40 × 70 ft and about 9 ft deep over one third of the area. This reservoir is connected by a channel 4 × 8 ft and 30 ft long to the test pit proper which is 8 × 8 ft and 25 ft deep. The bottom of the pit has the reinforcing steel placed in such a manner that a well 3 ft in diameter can be extended downward as far as required if this is deemed desirable at some future time. The channel or pit can be separated from one another or from the pool by gates for use as volumetric-calibration tanks. Electrical connections and control equipment are enclosed in sheet-metal houses.

Fig. 2 presents a view of the principal equipment and its

relative arrangement. The pump is mounted in the test pit, and the water is discharged into the main reservoir through a pipe placed above the channel and then returns to the test pit via the channel. The dynamometer is in place between the motor and the pump, the torque being measured by the scales. The small sheet-metal house contains electrical controls and instruments while the larger one houses the motor-generator set and the shop. The crane has a capacity of 5 tons and a clearance of 20 ft above the ground level.

Electrical energy available consists of 88 kva at 440 v or 44 kva at 220 v at 60 cycle frequency from the local public utility. Motor-generator sets of 50-kw capacity are installed in the laboratory. Tests requiring careful speed control will be made with the laboratory's 50-hp direct-current vertical hollow-shaft motor which is being equipped for constant-speed control within 1 rpm at steps of 50 rpm from 1100 to 1800 rpm.

For measuring power input to electric motors, the laboratory has installed accurate commercial electrical instruments. These include a wattmeter, voltmeter, and ammeter with appropriate current transformers and shunts for the higher powers required. These instruments will be calibrated at intervals against standards of the electrical-engineering department.

TEST FACILITIES

Power Input. - Power input to the driving motor is the electrical-energy input. Net power input to the pump is obtained usually from the electric-motor calibration that applies to a motor type and size, the actual calibration of the specific motor not being available, or from some type of transmission dynamometer. Dynamometers usually considered involve some means to determine torque as the reaction torque of the driving unit or the twist in a shaft as in the Amsler dynamometer. All methods involve serious problems, but the reaction-torque type appears to be capable of producing the most reliable data under a wide range of operating conditions.

Pump-manufacturers' test laboratories frequently use a vertical reaction-torque dynamometer to determine power input to the pump. The dynamometer often consists of an element placed between the pump and the motor which allows the motor stator to rotate with respect to the pump head or base. The torque exerted to prevent stator rotation is then taken as the torque input to the pump, the power being proportional to the product of the torque and speed of rotation. Although satisfactory for many purposes, this type of dynamometer is subject to inherent errors as air-pumping losses, friction in the bearing or bearings which allow relative movement, and torques exerted by connecting wires to the motor. When the stator is free to rotate, electrical losses, friction in the rotor bearings, and a portion of the normal windage loss has no effect on the reaction torque.

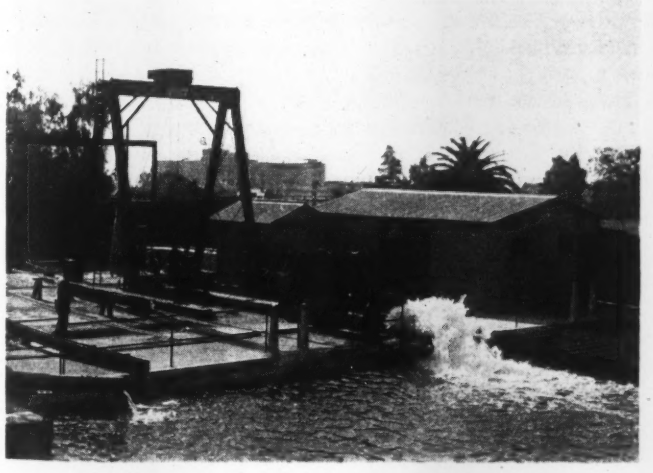

FIG. 2 RELATIVE ARRANGEMENT OF PRINCIPAL EQUIPMENT AT THE PUMP-TESTING LABORATORY OF THE UNIVERSITY OF CALIFORNIA

Pumping of the air used to cool the motor is a loss that is not eliminated in the dynamometer described. On the other hand, the correction to the dynamometer-measured torque is not the windage loss determined in tests of electric motors. Part of the torque exerted by the rotor on the air is transmitted through air drag on the stator parts as a torque of opposite direction on the stator. The only loss in energy affecting the torque measurement is due to the net rate of change in the moment of momentum of the cooling air in passing through the motor. Fig. 3 gives the magnitude of this correction versus speed for the laboratory 50-hp direct-current motor. The correction is to be subtracted from the measured torque to determine the net input torque to the pump.

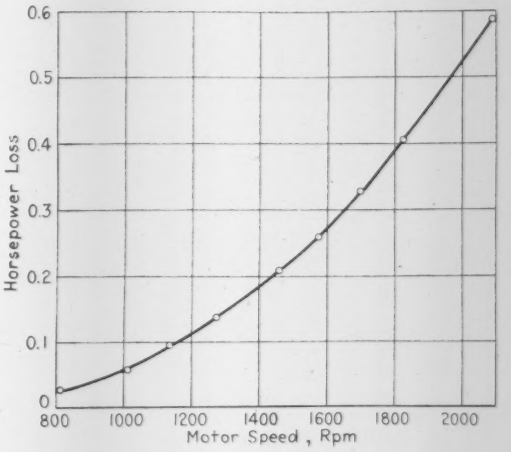

FIG. 3 AIR-PUMPING POWER LOSSES OF 50-HP VERTICAL DIRECT-CURRENT TEST MOTOR

(This curve is based on an air unit weight of 0.0766 lb per cu ft.)

The motor stator is mounted on a plate of the dynamometer which is constrained to rotate concentrically with the vertical pump shaft. Friction of the bearings on which the movable plate is mounted directly affects the measured torque. Although friction coefficients of ball bearings are low, friction forces in the bearings of the dynamometer plate are not negligible as these bearings support the total thrust load, hydraulic and mechanical, which, in deep-well pumps, is generally large as compared with the radial loads. The uncertainty in the torque reading caused by bearing friction may reach 3 per cent or more in extreme cases, the average magnitude being about 1 per cent.

Bearings for the movable plate of the vertical dynamometer correspond to those supporting the movable stator of the normal horizontal-shaft reaction-torque dynamometer. In the latter case, effects of friction can be reduced to a negligible value by slowly rotating the outer race of each bearing in opposite directions at equal speed. The success of this procedure depends on equal load distribution between bearings and conditions being maintained for equal friction coefficients at each bearing unit. A similar method of opposite rotation of the outer races of two equally loaded thrust bearings in the vertical dynamometer would be desirable, but the design of such a unit is complicated.

As a compromise, the reaction-torque dynamometer con-

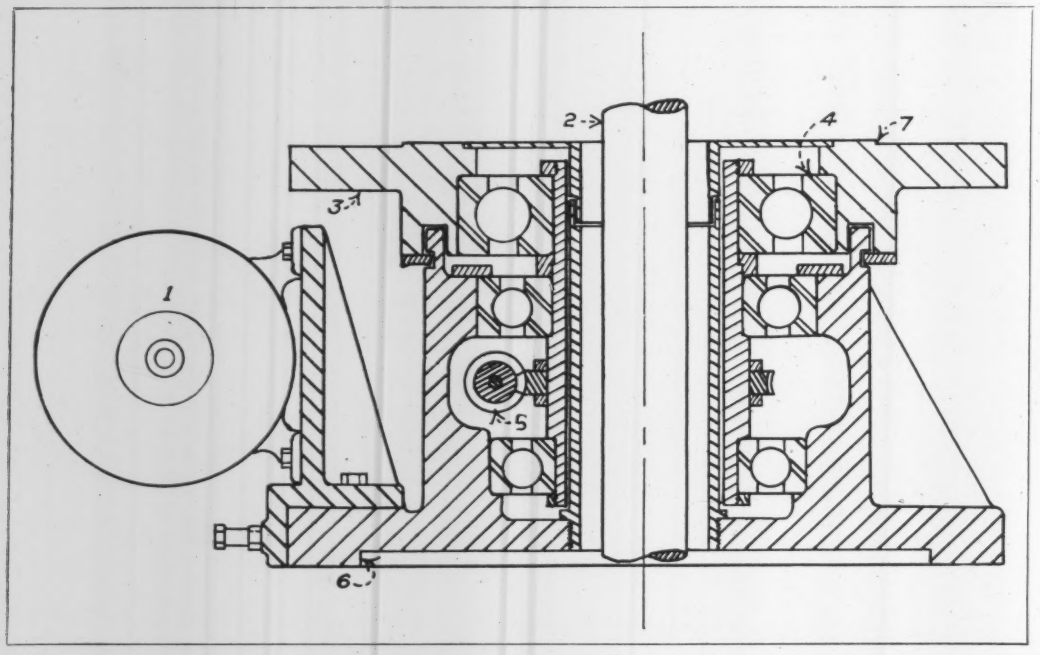

FIG. 4 VERTICAL REACTION-TORQUE DYNAMOMETER HAVING A MAXIMUM THRUST RATING OF 10,000 LB

(1, 1/4-hp motor; 2, pump shaft; 3, movable plate; 4, plate thrust bearing; 5, worm gear; 6, pump-head or thrust-meter fit; and 7, pump-motor fit.)

structed for the Berkeley laboratory has provisions for rotating the inner race of the plate bearing at the same speed in either direction. Thus, for a resultant torque measurement, two readings are necessary, each with the inner race rotating in a different direction, while the motor rotor always turns in the proper direction for pumping.

In equation form

$$A_1 = T_f + T_M$$
$$A_2 = -T_f + T_M$$
$$(A_1 + A_2)/2 = 2T_M/2 = T_M$$

where A_1, A_2 are measured torques for different directions of rotation of inner bearing race; T_f is friction torque of plate bearing; and T_M is net reaction torque of motor.

Fig. 4 shows the essential elements of the vertical dynamometer which has a maximum-thrust rating of 10,000 lb. This unit has proved satisfactory in preliminary tests, the only requirement being that the viscosity of the lubricating oil for the plate bearing does not change appreciably between the two determinations. The 1/4-hp motor supplies energy to rotate the inner races of the three ball bearings. The drive is through a V-belt between the motor and worm-gear shaft, producing a resultant rate of rotation of the inner hollow shaft of about 12 rpm. Frictional losses in the radial and lower thrust bearings have no effect on the torque measurements.

The resisting force required to prevent rotation of the movable plate is measured on a 75-lb Toledo scale having 1-oz graduations. It is transmitted by a wire from the periphery of the movable plate over a pulley having ball bearings to a weight placed on the scale. The alignment is made in such a way that any extension of the wire or displacement of the scale balance pan during loading has no measurable effect on torque measurements. The movable plate is prevented from moving more than about 1/2 in. at the periphery by a pair of stops fastened to the stationary part of the dynamometer.

Thrust load on the shaft caused by hydraulic pressure, and shaft and impeller weights must be supported by a thrust bearing. The location of the thrust support depends on the particular commercial construction, that is, solid-shaft motor with solid coupling, hollow-shaft motors, or solid-shaft motor with flexible coupling. The first two types have the thrust bearing built into the motor as one of its bearings while the last has the thrust bearing in the pump base.

When the thrust bearing is built into the motor, power-input measurements by the dynamometer of Fig. 4 charge the friction losses of this bearing against the motor, the method specified by the Hydraulic Institute. Losses are small in angular-contact ball bearings, the type almost universally applied to deep-well turbine pumps. The average is about 1 or 2 per cent for a normal installation but may become three or four times this value for exceptional conditions. Approximate data are available regarding the magnitude of the loss under normal conditions, but little or nothing is known about variations to be expected under operating conditions in pumps. If a calibrated motor is applied for power-input determinations, it becomes necessary to know the frictional losses in the thrust bearings. When the thrust bearing is mounted in the pump base, power input measured by the dynamometer includes bearing losses.

Thrust Meter. The total thrust load is usually taken as the weight of the shafting and impellers plus the computed hydraulic thrust. As the thrust load directly affects the thrust-bearing losses and the design of shafting, an instrument to measure total thrust under operating conditions in the laboratory is under construction. Fig. 5 indicates the principal elements of the meter. The total thrust is twice the value of the force indicated by the pressure gage which is attached to the Emery pressure capsule. This capsule is similar to units built into materials-testing machines. The gage has a 10,000-lb capacity and is graduated in 20-lb divisions. The unit will be calibrated with proving rings and checked at intervals.

Capacity. Rate of fluid-discharge measurements can be made with a large variety of instruments, the accuracy depending on the type of instrument and attention devoted to the details of its application. Standard I.S.A. nozzles of corrosion-resisting bronze are used as metering elements for the laboratory quantity-rate meters. The capacity of the series of meters is between 0.10 and 9.50 cfs. Nozzles are placed between flanges with corner-tap pressure connections. The metering unit includes a section of straight pipe of 20 diameters length or greater upstream from the nozzle and a downstream section of 5 diameters or more in length. All pipes are galvanized and the

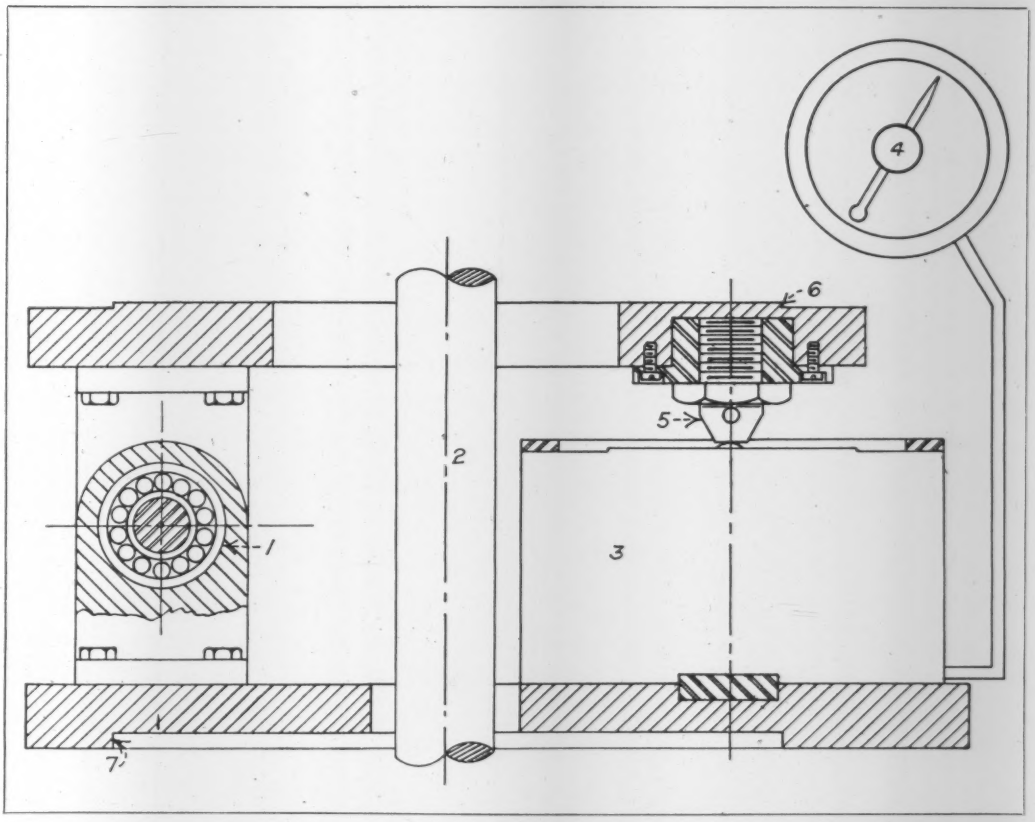

FIG. 5 THRUST METER

(1, precision ball bearings; 2, pump shaft; 3, Emery pressure capsule; 4, pressure gage; 5, position adjustment; 6, pump-motor or dynamometer fit; and 7, pump-head fit.)

flanges holding the nozzles are tin-plated. Ratios of nozzle-to-pipe areas vary from 0.30 to 0.38.

The heads across the nozzles are measured by a water-air differential manometer having a range of about 9 ft of water. Air pressure inside the manometer is measured and observations of temperatures of water columns are included. Manometer scales are divided by 0.01-ft marks and readings are estimated to 0.001 ft. Manometer-tube inside diameters are about 1 in. to reduce effects of capillarity to a negligible magnitude.

Metering units, that is, nozzle, flanges, and up- and downstream sections of pipe were calibrated volumetrically. The first series of calibration shows a spread of ± 0.3 per cent from the average coefficient. A comparison with the values specified by the "Regeln"[4] demonstrates the coefficients of the laboratory nozzles to be within 0.8 per cent of the specified coefficient, which is also within the allowable tolerances. Meter units are calibrated at intervals to determine coefficient changes.

Head. Pump pressures are measured with water-air or mercury-water manometers, or fluid-pressure scales as the particular case requires. In dealing with vertical-shaft pumps, the elevation of the water in the sump is required. This is measured by a weighted stainless-steel tape graduated in 0.01 ft and equipped with a vernier to obtain readings to 0.001 ft Water-surface elevation is indicated by a neon glow lamp which lights when the point of the weight touches the water. Use is made of the same tape in volumetric calibration of the nozzles.

Speed of Rotation. Speed of rotation is measured by solenoid-operated stop watch and revolution counter, both solenoids being operated from the same switch. The stop watch is compared frequently with an accurate time source.

Since the new pump-testing laboratory contains special equipment for testing vertical-shaft centrifugal pumps, the initial problems are connected with deep-well turbine pumps. The work of the laboratory includes the following problems:

(1) Investigation of methods of water measurement to provide data from which satisfactory measurements of pump-discharge rates can be made under a large variety of laboratory and field conditions.

(2) Determination of normal characteristics of new deep-well turbine pumps to provide data necessary in specifying reasonable pump characteristics for a given installation.

(3) Measurement of hydraulic-friction losses in riser columns to correct laboratory-performance characteristics to a particular field installation of a given pump.

(4) Investigation of mechanical-friction losses in ball-thrust and plain-radial bearings under conditions of application to deep-well turbine pumps to obtain data for design of bearings with minimum friction loss and maximum life.

(5) Determination of changes in pump characteristics caused by wear produced by abrasive materials like sand in the water being pumped.

(6) Calibration of vertical-shaft electric motors to determine performance under actual operating conditions.

(7) Determination of pump-thrust loads to provide data for design and corrections to the motor efficiencies for friction losses in the thrust bearing.

(8) Development of a complete deep-well pump-testing code for laboratory and field conditions including the accuracy to be expected in the different types of instruments and measurements.

ACKNOWLEDGMENTS

The laboratory is being developed under the supervision of Prof. M. P. O'Brien and the author. Actual tests are conducted by H. E. Burrier and W. Johnson. Equipment has been constructed and assembled by A. B. McIntyre assisted by the WPA project sponsored by the department of mechanical engineering.

[4] See "Regeln für die Durchflussmessung mit genormten Düsen und Blenden," DIN 1952, V.D.I., Berlin, 1937, work sheet No. 5.

SERVICEABILITY *of* GLUE JOINTS

Exposure Tests Give Data on Animal, Vegetable, Casein, and Blood Types

By DON BROUSE

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TESTS HAVE demonstrated that among the more important causes of failure of well-made glue joints in service are (*a*) chemical hydrolysis of the glue, (*b*) destruction of glue by microorganisms, and (*c*) mechanical stresses developed on the glue joint as the wood changes dimensions under the effect of changes in moisture content. The relative importance of these different factors varies largely, depending on the type of glued construction, variety of glue, and service conditions.

The significance of hydrolysis and its relation to composition has been developed for casein glues (1),[1] and the general principles are believed to apply to other protein glues. Under conditions favorable to decay, the destructive effect of microorganisms on glues of compositions that serve as food has been shown to be rapid and drastic. However, it may be greatly reduced by incorporating toxic materials in the glue or by adequate treatment of the entire glued members with toxic preservatives (2). The effect of microorganisms on the glue joint and deterioration due to hydrolysis may, of course, be eliminated by selecting adhesives that are not subject to attack by molds and do not hydrolyze.

The effect of mechanical action, however, cannot be greatly retarded by minor changes in formulation, although these changes might have a marked effect on the rate of hydrolysis. Nor will the mechanical effects be changed to any significant degree by adding toxic materials to the glue or by treating the glued members with chemicals commonly used for wood preservation. The primary requirement, if the glue joints are to maintain their strength under repeated changes in moisture conditions, appears to be a glue that is strong enough either in a wet or a dry condition of the wood to withstand the stresses developed under severe conditions of service.

Failure of well-made glue joints under stresses developed by changes in moisture content may be thought of as depending on (*a*) the magnitude of the stresses developed and (*b*) the degree to which the glue softens and weakens when it becomes moist. The magnitude of the mechanical stresses developed depends on the extent of the moisture changes and how far the extremes of moisture content depart from that of the stock at the time the glue sets; also upon the density and shrinkage characteristics of the species used and the thickness of the laminations. The resistance that the glue line offers to these stresses may be thought of as depending on the quantity of water absorbed by the glue line and the degree to which the glue softens and loses its strength when this absorption occurs. Glues that are water-resistant will withstand exposure to higher humidities than those lacking this property.

Tests were conducted at the Forest Products Laboratory to determine the relative resistance of some commonly used wood-working adhesives to service conditions involving successive exposures to alternating conditions of moisture that would develop mechanical stresses of increasing magnitude on the glue joint. The purpose was, further, to define, if possible, the conditions of service under which glue joints could be expected to remain permanently durable and the conditions under which either prompt or ultimate failure could be expected.

In these tests, the complications of species characteristics and thickness combinations were eliminated by the use of a single species and a single thickness combination throughout, although it is recognized that these factors must be considered when general applications of the results are made. Further, the tests do not include the more recently developed synthetic-resin adhesives. Other tests, however, have indicated that joints made with hot-pressed synthetic resins are highly resistant to conditions favoring mold attack and hydrolysis and that they retain a high percentage of their dry strength when saturated with water or exposed to high humidities.

TEST PROCEDURE

Seventeen panels, each of which was 12 in. square and composed of three plies of selected $^1/_{16}$-in. yellow-birch veneer, were glued with each of seven glues. They were (*a*) sodium-silicate-lime-casein glue mixed according to formula 4B of the Forest Products Laboratory, (*b*) and (*c*) two sodium-hydroxide-lime-casein glues, (*d*) high-grade animal glue having a jelly strength of 303 g and a viscosity of 108 millipoises, (*e*) low-grade animal glue having a jelly strength of 190 g and a viscosity of 65 millipoises, (*f*) commercial vegetable or starch glue, and (*g*) hot-press blood glue mixed according to the paraformaldehyde formula of the Forest Products Laboratory. In Table 1, which gives the composition of these glues on a parts-by-weight basis, the individual glues are designated by the letters used in the preceding sentence.

TABLE 1 COMPOSITION OF GLUES USED IN TESTS

Constituents	Glue (*a*)	(*b*)	(*c*)	(*d*)	(*e*)	(*f*)	(*g*)
Ammonium hydroxide	...	...	...	...	...	...	5.5
Animal glue	...	...	...	100	100	...	...
Blood albumin	...	...	...	...	...	...	100
Casein	100	100	100	...	...	...	...
Lime	28	15	15	...	...	...	...
Paraformaldehyde	...	...	...	...	...	...	15
"Processed" starch	...	...	...	...	...	100	...
Sodium hydroxide	...	12	4	...	...	3	...
Sodium silicate	70	...	...	...	...	...	...
Water	330	240	380	225	195	225	190

The veneer was conditioned to approximate equilibrium with 30 per cent relative humidity before gluing, which brought it to a moisture content of about $6^1/_2$ per cent. The gluing conditions were adjusted to fall within limits favorable to the production of good joints (3) with each glue. The gluing operations with animal, casein, and vegetable glues were carried out in the conventional way. The panels glued with blood albumin were spread and pressed at room temperatures, allowed to remain under pressure overnight, and hot-pressed the following morning for about 10 min at 260 F and under a pressure of 200 lb per sq in.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

After gluing, the panels were again conditioned to approximate equilibrium with 30 per cent relative humidity and then cut into standard plywood test specimens (3). Each of the 17 panels yielded 30 test specimens, giving a total of 510 for each glue. Five specimens from each panel were tested dry, and any panels that gave low or erratic test values were discarded.

Specimens from the remaining panels of each glue were then mixed together to insure random sampling and divided into 6 groups of 60 each, one group for each of the tests listed in Table 2. Air temperatures were maintained at approximately 80 F, while the soaking water temperatures of test No. 6 varied with those of the laboratory. Five specimens were withdrawn from each group and tested on a plywood-testing machine of conventional design (3) at intervals of 4, 8, 12, 16, 20, 40, 60, 80, 120, and 160 weeks. Specimens were unprotected, and their dimensions were small enough to permit the wood to attain approximate equilibrium with atmospheric conditions at each period of the exposure cycle.

TABLE 2 DATA ON EXPOSURE TESTS

Test	Type of exposure cycle	First stage: Time, days	First stage: Relative humidity, per cent	Second stage: Time, days	Second stage: Relative humidity per cent
1	Continuous[a]	..	30	..	30
2	Alternating	14	60	14	30
3	Alternating	14	80	14	30
4	Alternating	14	90	14	30
5	Alternating	14	97	14	30
6	Alternating	2[b]	[b]	12	30

[a] Used as controls.
[b] Soaked in water at room temperature.

In analyzing the data from the tests, the average test value of each group that remained in 30 per cent relative humidity was considered a "control" average and other test values of specimens glued with the same glue were expressed as percentages of this. As the different exposures were continued and test values were obtained at different intervals, these were converted into percentages and plotted. After plotting, the points were joined by straight lines to illustrate general trends in strength changes. No attempt has been made to draw curves of mathematical exactness because the number of specimens tested at each period was not sufficient to justify such treatment. The tests have extended over a sufficient period of time, however, to permit confidence in the general tendencies illustrated.

ANIMAL AND VEGETABLE OR STARCH GLUES

Both animal and vegetable or starch glues are lacking in water resistance, and the durability of joints made with them and exposed to water or to damp atmospheres is so similar that the results were averaged together and shown on the same curves, Figs. 1 and 2. When exposed to test No. 6, a soaking-drying cycle, all joints made with either animal or vegetable glue separated completely either in the first soaking period or in the drying that immediately followed (Fig. 2). This behavior is to be expected of glues that are not water-resistant.

Specimens, glued with animal or vegetable glue, exposed to test No. 5 did not separate immediately, but at the first test period, the end of the first complete cycle, the average joint strength was less than 40 per cent of the original. All specimens had failed before the end of the fourth cycle, or in somewhat less than 16 weeks. This test does not involve exposure to free water, but a relative humidity of 97 per cent is sufficiently high to permit development of molds and to bring the moisture content of the wood to about 28 per cent during the "wet half" of the cycle. Specimens exposed to test No. 4 failed less rapidly than those exposed to test No. 5. They had decreased in strength, however, by some 50 per cent by the end of the first test cycle, and all specimens had failed by the end of 36 weeks. Moisture content of the wood during the "wet half" of this cycle probably reached about 22 per cent (Fig. 1).

In test No. 3, more than 20 weeks of exposure were required before the average test values had fallen to 50 per cent of the original. By the end of the eighty-first week, however, all specimens had failed indicating that animal- and vegetable-glued joints cannot be depended upon to remain permanently durable when exposed to conditions where the wood may at times exceed about 17 per cent moisture content, which is approximately the equilibrium condition for 80 per cent relative humidity (Fig. 1). These results may appear contrary to experience, for furniture glued with starch and animal glues often serves satisfactorily in spite of occasional exposures to relative humidities in excess of 80 per cent. In those cases, however, the protection afforded by the finish may prevent the wood's reaching the equilibrium moisture content of 17 per cent, particularly if the exposure to dampness is not prolonged.

In tests Nos. 1 and 2, no evidence of significant loss in strength could be detected during the 160 weeks that the tests were in progress. Test No. 2 approximates the changes in moisture content that can be expected in interior woodwork

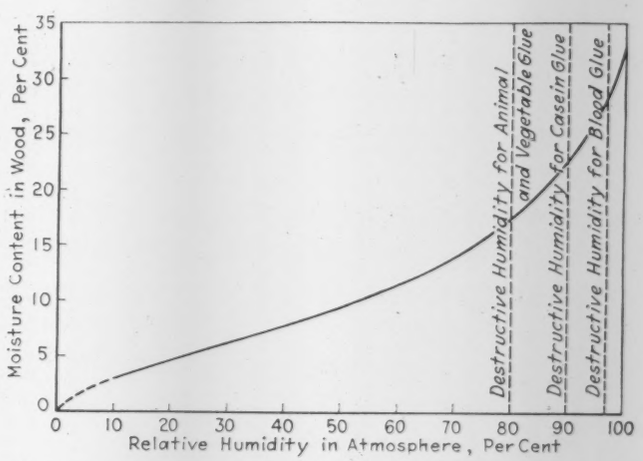
Moisture Content in Wood, Per Cent
Relative Humidity in Atmosphere, Per Cent
Destructive Humidity for Animal and Vegetable Glue
Destructive Humidity for Casein Glue
Destructive Humidity for Blood Glue

FIG. 1 RELATION BETWEEN MOISTURE CONTENT OF WOOD, RELATIVE HUMIDITY OF SURROUNDING ATMOSPHERE AT 70 F, AND DESTRUCTIVE CONDITIONS FOR DIFFERENT GLUES

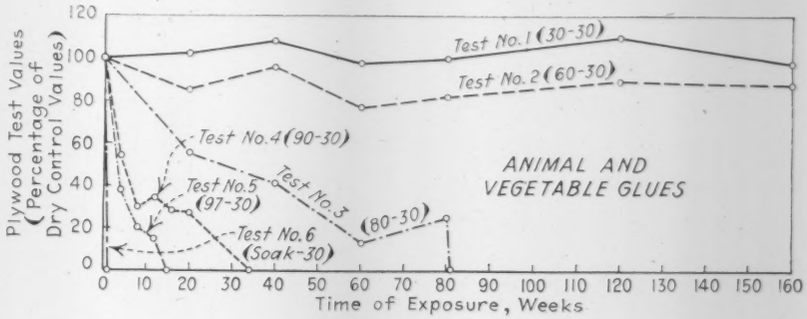
Plywood Test Values (Percentage of Dry Control Values)
Time of Exposure, Weeks
Test No. 1 (30-30)
Test No. 2 (60-30)
Test No. 4 (90-30)
Test No. 5 (97-30)
Test No. 3 (80-30)
Test No. 6 (Soak-30)
ANIMAL AND VEGETABLE GLUES

FIG. 2 RATE OF DETERIORATION OF ANIMAL- AND VEGETABLE-GLUE JOINTS IN PLYWOOD UNDER VARYING CONDITIONS OF EXPOSURE

in normal use in heated buildings in the northern part of the United States (4). In this type of service, properly designed and well-made joints of animal or vegetable glue should prove permanently durable, and experimental evidence, other than these tests, supports that belief (5).

CASEIN AND BLOOD GLUES

When exposed to conditions that cause alternating changes in the moisture content of wood, the casein glues used in these experiments displayed no great differences among themselves in durability of joint. Results from the three casein glues have been averaged together, therefore, and are shown in a single set of curves as Fig. 3. They are believed to be typical of the general tendencies that would develop when any of the better grades of casein glue are subjected to similar tests.

Results of test No. 6 illustrate that joints made with casein glue cannot be termed waterproof. In this series of soaking-drying tests, all specimens glued with casein glue had failed by the end of 15 weeks. In other similar tests (6), similar results have been obtained. While the time of total failure has varied from 3 to 15 months, an early weakening of the joints was apparent in all similar tests.

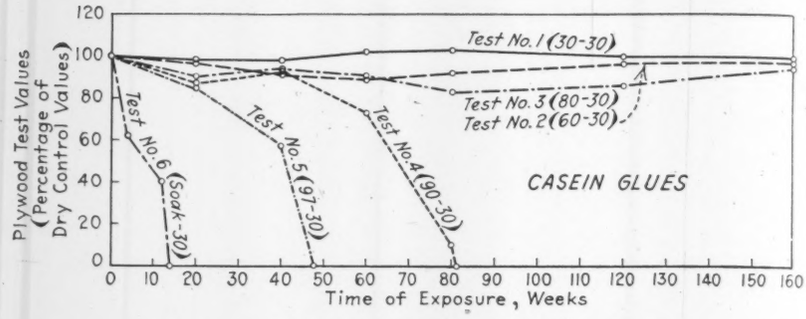
Plywood Test Values (Percentage of Dry Control Values)
Time of Exposure, Weeks
Test No. 1 (30-30)
Test No. 3 (80-30)
Test No. 2 (60-30)
Test No. 4 (90-30)
Test No. 5 (97-30)
Test No. 6 (Soak-30)
CASEIN GLUES

FIG. 3 RATE OF DETERIORATION OF CASEIN-GLUE JOINTS IN PLYWOOD UNDER VARYING CONDITIONS OF EXPOSURE

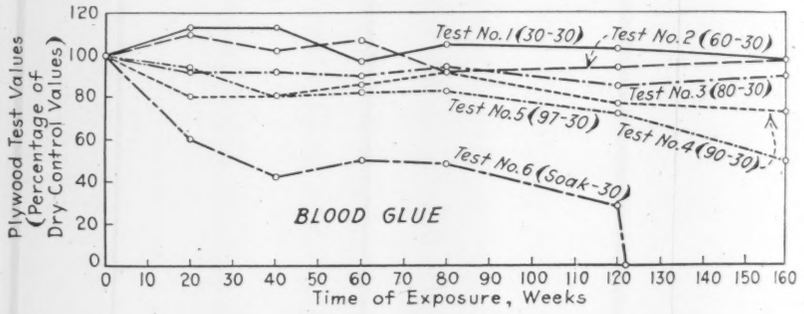
Plywood Test Values (Percentage of Dry Control Values)
Time of Exposure, Weeks
Test No. 1 (30-30)
Test No. 2 (60-30)
Test No. 3 (80-30)
Test No. 5 (97-30)
Test No. 4 (90-30)
Test No. 6 (Soak-30)
BLOOD GLUE

FIG. 4 RATE OF DETERIORATION OF BLOOD-GLUE, PARAFORMALDEHYDE-FORMULA, GLUE JOINTS IN PLYWOOD UNDER VARYING CONDITIONS OF EXPOSURE

Exposure to 97 per cent relative humidity followed by drying, test No. 5, also causes rapid weakening of unprotected casein-glue joints with total failure occurring in these tests at about 48 weeks or 12 complete cycles. Even the cycle of 2 weeks in 90 per cent relative humidity followed by 2 weeks's drying in 30 per cent relative humidity, test No. 4, was severe enough to cause ultimate failure of unprotected casein-glue joints. The rate of failure is slower than that displayed by joints of vegetable or animal glue exposed to the same conditions, but at the end of some 81 weeks, 20 complete cycles, all casein joints had failed.

In test No. 3, however, no evidence of significant weakening of joint strength was disclosed during the 160 weeks that the tests were in progress. The difference in resistance between casein and animal or vegetable glues is demonstrated in this test. Well-made casein-glue joints are apparently able to withstand repeated exposures to 80 per cent relative humidity while joints made with starch or animal glues ultimately fail in this exposure. Tests Nos. 1 and 2 failed to disclose any weakening of well-made casein-glue joints while the tests were in progress and none would be expected, regardless of the length of time that the tests might be extended.

Until the development of artificial-resin glues, the "hot-press" paraformaldehyde blood glue was one of the most water-resistant of woodworking adhesives. In test No. 6, specimens held together for nearly $2^1/_2$ years (Fig. 4) before total failure, and, in other similar tests, specimens have withstood the cycle for as long as 3 years. Even this resistant glue, however, cannot be classified as waterproof, for severe moisture changes repeated over a long time will cause failure in the joint.

At the end of 160 weeks, blood-glue joints exposed to test No. 5 had lost approximately 50 per cent of their original strength. From the downward trend in joint strength illustrated in Fig. 4, total failure might be expected somewhere between 4 and 5 years. In other similar tests, however, blood-glue joints have withstood this exposure for as long as 6 years and, at the end of that time, the joints retained some 40 per cent of their original strength. By that time, the wood which had been exposed to the cycle of 97 per cent relative humidity followed by 30 per cent was beginning to show some evidence of decay.

From the trend illustrated in Fig. 4, ultimate failure might be expected in blood-glue joints exposed to test No. 4. In view of the long resistance to the more severe test No. 5, however, it appears reasonably safe to assume that these joints might, on more extensive tests, prove permanently durable as long as the moisture content of the wood did not exceed approximately 22 per cent (Fig. 1). These tests produced no evidence that well-made blood-glue joints will fail when subjected to tests Nos. 1, 2, or 3.

Destructive humidities appear to be between 60 and 80 per cent relative humidity, corresponding to a maximum equilibrium moisture content in wood of about 17 per cent, for animal and vegetable or starch glues; between 80 and 90 per cent relative humidity, corresponding to a maximum equilibrium moisture content in wood of about 22 per cent, for casein glue; and between 90 and 97 per cent relative humidity, corresponding to a maximum equilibrium moisture content in wood of about 27 per cent, for blood glue.

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FLUID-MECHANICS LABORATORY

And Its Place in Undergraduate Mechanical-Engineering Training

By JOHN R. WESKE

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WITH THE introduction of special courses in fluid mechanics into the undergraduate curriculum in mechanical engineering, development of fluid mechanics laboratories has been undertaken. Although an integral part of the mechanical-engineering department, this laboratory is ordinarily separate from the general mechanical-engineering laboratory and, in some cases, it is combined with the aerodynamics laboratory. Since, at Case School of Applied Science, aerodynamics, an optional senior or graduate course, is regarded as an organic continuation of fluid mechanics, a distinction existing only in regard to emphasis on practical application, the same laboratory serves both courses. For that reason, the following discussion will also relate to laboratory work in aerodynamics. As in other branches of engineering training, the laboratory and classroom work fulfill mutually complementary functions. The purpose of the fluid-mechanics laboratory and its place in the undergraduate curriculum, therefore, is best understood from the nature of the course. Hence, a few words in regard to the latter may be in order.

Fluid mechanics is regarded as a branch of applied mechanics, and, thus, it is closely related to the basic engineering sciences and is tending to assume a place in the curriculum similar to that of thermodynamics. Like the latter, it bears largely on selected fields of physics as to subject matter, while at the same time it emphasizes the practical aspects of engineering. It provides the common basic training for a number of engineering courses of application character, such as steady-flow machines, aerodynamics, and heating and ventilation. In addition, it is a service course in the widest sense of the word, since it furnishes the knowledge necessary for a proper appreciation of the flow problems in all branches of engineering.

In common with thermodynamics, fluid mechanics also has certain inherent difficulties encountered in the instruction of the subject matter. It is frequently observed that the majority of engineering students have acquired a considerable knowledge of the laws of solid mechanics by direct observation, which is an invaluable aid in the teaching of general mechanics. Ability to visualize the flow of fluids, or the exchange of heat energy, generally is developed to a considerably lesser degree. It must, therefore, be one of the principal aims of instruction in fluid mechanics to give the student adequate opportunity for direct observation and personal experience in the investigation of fluid flow. Thus he will acquire a store of information through which he can develop an understanding of the laws of fluid flow, an ability to analyze involved situations encountered in practice, and, ultimately, genuine professional judgment.

LABORATORY WORKS IN FLUID PHYSICS AND MECHANICS

Since the physics of fluids presents a relatively large number of problems that do not yet lend themselves to theoretical solution, actual experiments supplementing theoretical considerations appear to be particularly desirable in this field. An example of the important part that basic experimental evidence plays in supplying engineering data is presented by the flow in the boundary-layer zone and its manifold effects upon resistance. Wherever it is possible and time permits, it is desirable to coordinate problem assignments with simple laboratory tests furnishing the numerical data, as this aids greatly in convincing the student of the practical value of the assigned work. Fluid-mechanics problems also furnish frequent opportunity to apply advanced methods of mathematical analysis to engineering problems.

Laboratory work in fluid mechanics deals largely with basic phenomena, tending to the abstraction and isolation of the controlling factors, whereas corresponding work in the mechanical-engineering laboratory is more concerned with the performance characteristics of hydraulic equipment and fluid-handling machinery. It appears therefore logical that each should have a place in the curriculum. The foregoing considerations have stressed the value and the necessity of demonstration tests and laboratory work in fluid mechanics. It remains to point out its specific objectives. The requisites of the fluid-mechanics laboratory are summarized in the following list of its purposes:

(1) The fluid-mechanics laboratory should include a collection of demonstration objects and apparatus for use in connection with the lectures. These objects should not be dead museum pieces, since they then would be of little value for instruction. Their design should be such that they can be handled by the student and, wherever feasible, operated. They should include apparatus for demonstration of fluid flow.

(2) The laboratory further should have equipment for the application of all existing methods of experimental investigation of fluid flow that are of practical importance in engineering work.

(3) In case laboratory time is provided in the curriculum for fluid mechanics, a variety of laboratory tests for student instruction should be performed under student leadership, assisted by the direction of the instructor.

(4) A modern laboratory should resemble an industrial development and design department in this respect, namely, it should be a place where, in addition to tasks of professional routine, are found engineering problems that are still unsolved. This will stimulate the initiative and resourcefulness of the students. It will also impress upon them the fact, so easily overshadowed at graduation time, that large domains of engineering knowledge exist which have been barely skirted in the prescribed courses.

The study of fluid flow can be approached in two different ways, (*a*) through direct observation of the fluid motion and (*b*) through observation and measurement of the effect of fluid flow, such as the forces exerted on immersed bodies or the pressures produced on bounding solid surfaces.

Direct observation of the flow of fluids is possible much more readily than that of the flow of electricity, for instance, where observations are almost entirely confined to the effects of a current. Fluid motion can be made visible by particles suspended in the fluid or floating on its free surface, if the latter exists. Textile threads or tapes, used either singly or suitably arranged in multiples for simultaneous observation, are the

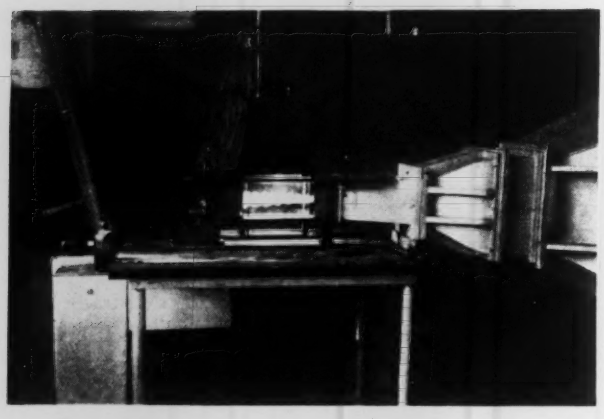


FIG. 1 SMOKE TUNNEL FOR OBSERVING AND STUDYING AIR FLOW

FIG. 2 FLOW PICTURES OBTAINED WITH KEROSENE AND LAMPBLACK

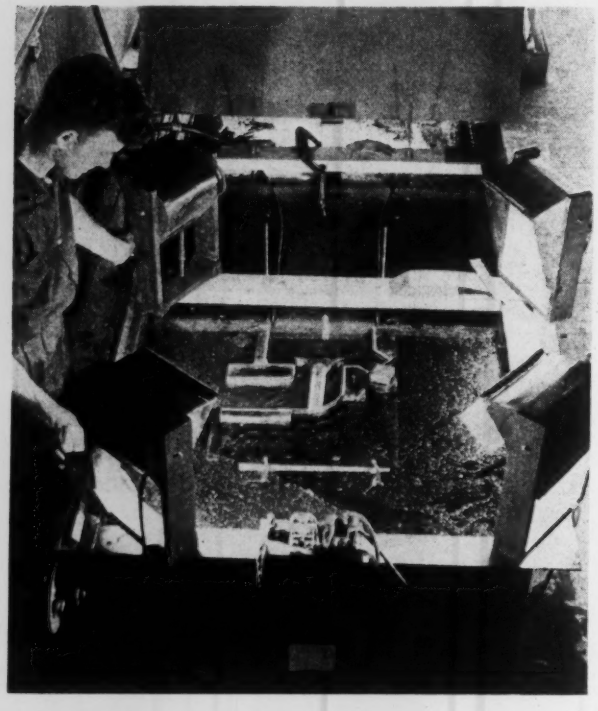


FIG. 3 FLOW THROUGH A MODEL OF AN INTERNAL-COMBUSTION ENGINE VALVE

simplest means for determining the direction of flow. Their weight and inertia, however, limit their use, particularly in turbulent flow. Individual streamlines or entire streamline patterns are readily made visible by smoke vanes. Smoke may be produced by burning various substances or, because of simplicity of its production and its density, preferably from tetanium tetrachloride. Since smoke from the latter source is irritating and corrosive, provision must be made for its disposal if it is used in larger quantities. Fig. 1 shows a small smoke tunnel for the observation and study of air flow. Air is drawn by a fan through the test section of 6 × 6 in. cross-sectional area from a carefully tapered inlet cone and discharged into a chimney. With this apparatus, smoke pictures of two- and three-dimensional flow may be obtained for Reynolds' number as high as 30,000, based on the dimensions of the test section. For two-dimensional investigations, stable and clearly defined smoke threads may be obtained by making the width of the test section small.

There is an alternative way of making streamlines visible by the well-known method of using fine streams of dye in liquids. In this way, flow patterns can be produced which closely resemble potential flow patterns, as shown by Professor Parr in a paper published recently in MECHANICAL ENGINEERING.[1]

Of considerable interest and occasional practical use is the kerosene-and-lampblack method shown in Fig. 2. Since smoke generally cannot be used in the large wind tunnel of the laboratory because of its corrosive action and annoying odor, experiments have been made in the wind tunnel with the Schlieren or streak method, which have met with good results. Differences in density of the air are produced by minute electrically heated platinum wires. The shadows thus produced by the rays of an arc light are projected against a screen. While for direct observation, satisfactory results are obtained without lenses, it is necessary, for photographic purposes, to increase the light intensity through application of lenses and filters.

ALUMINUM-POWDER FLOW PATTERNS

If two-dimensional investigations are adequate, observation of the motion of aluminum powder or similar light particles floating on the surface of water is frequently preferable, since it renders the flow pattern visible in greater detail and gives information regarding velocities with less effort than is required for smoke pictures. To obtain good results, it is necessary to use great care in reducing the surface tension of the water. Simple flow pictures with aluminum powder can be obtained in a shallow pan having a surface area of a few square feet, if nothing else is available. A tank of considerable size, 10 ft long, 3 ft wide, and $2\frac{1}{2}$ ft deep (Figs. 3 and 10), was constructed for this purpose. It can be used for several types of investigations, namely:

(1) For obtaining flow pictures by the aluminum-powder method by towing models through the water. The hydraulic towing mechanism used for that purpose was first applied in this country to a similar tank by J. P. Den Hartog. It seems that this is the best method to show the starting vortex of an airfoil and thus to introduce the student to the vortex theory of airfoils.

(2) For producing flow pictures with the water moving and the model at rest. In this case, the water is circulated by a series of jets. This method is effective for demonstrating flow through orifices and valves and through two-dimensional models of internal-combustion engine cylinders. An example

[1] "Fluid-Flow Analyzer," by H. L. Parr, MECHANICAL ENGINEERING, vol. 59, June, 1937, pp. 437–439.

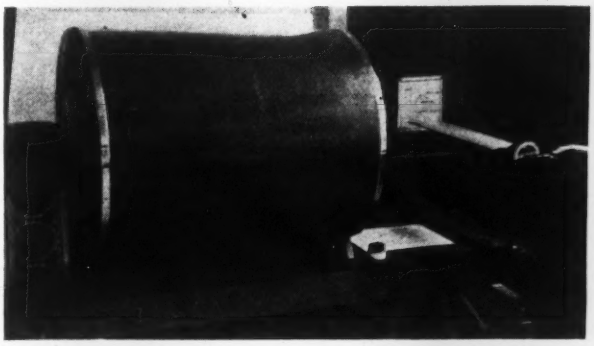


FIG. 4 AIR-JET DEMONSTRATION

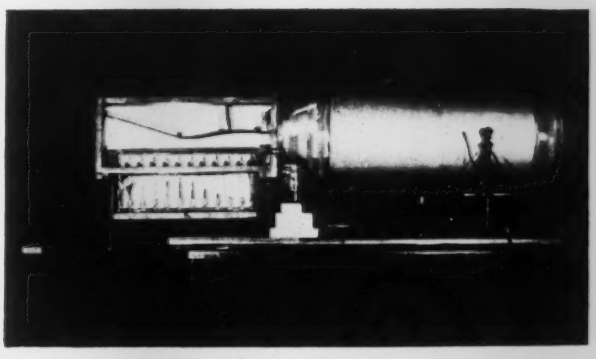


FIG. 5 SMALL AIR JET AND VARIABLE CROSS-SECTION CHANNEL

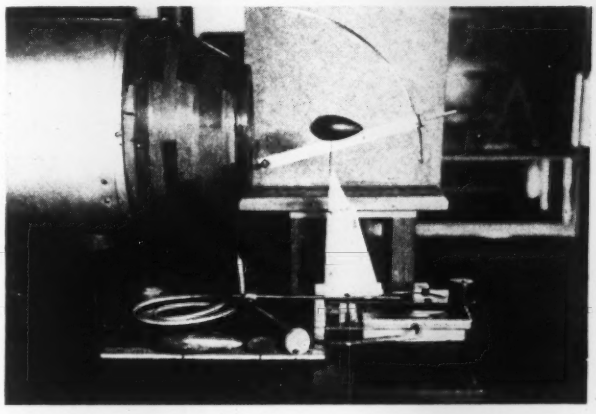


FIG. 6 MEASURING DRAG WITH HYDROSTATIC SCALE

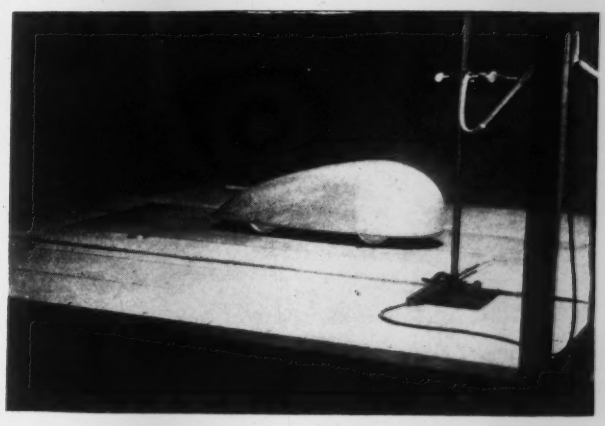


FIG. 8 MOVING BELT FOR TESTING AUTOMOBILE MODELS

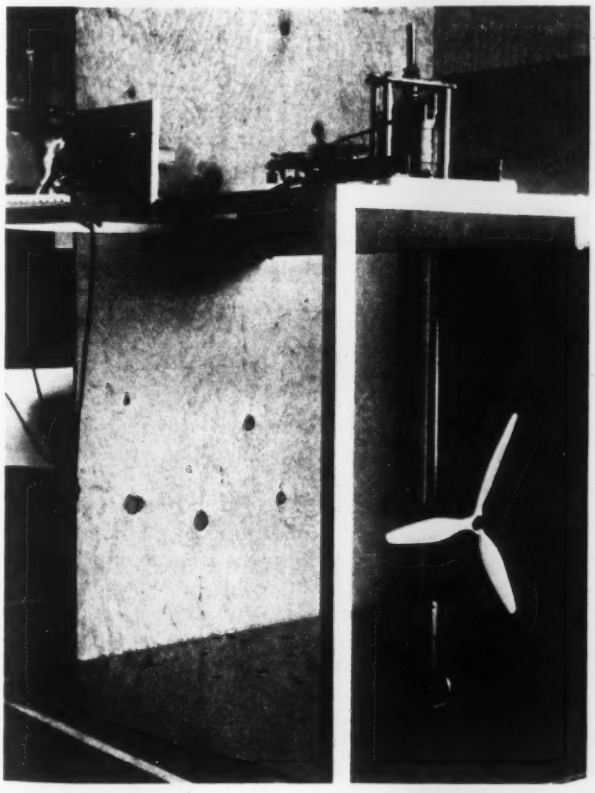


FIG. 7 MODEL PROPELLER-TESTING STAND MOUNTED IN WIND-TUNNEL CRADLE

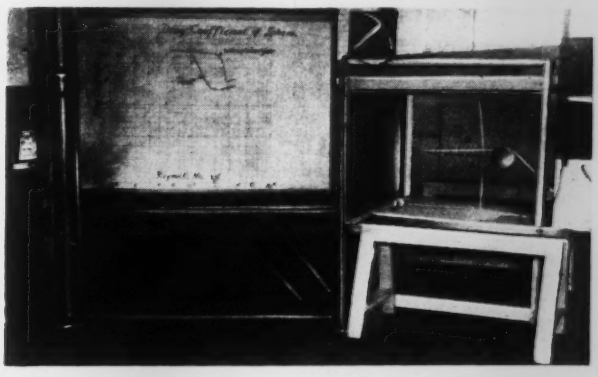


FIG. 9 RESULTS OF WIND-TUNNEL TESTS ON SPHERE AND SETUP USED

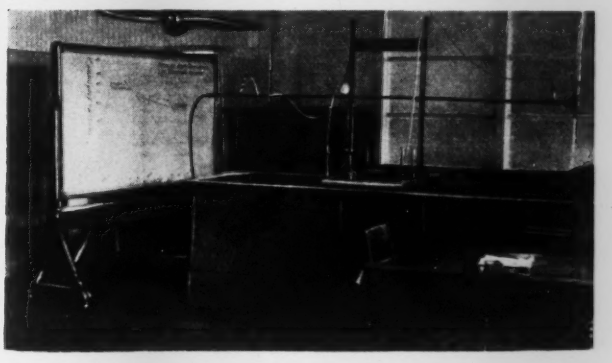


FIG. 10 ARRANGEMENT FOR DEMONSTRATING PRESSURE DROP IN PIPE LINES

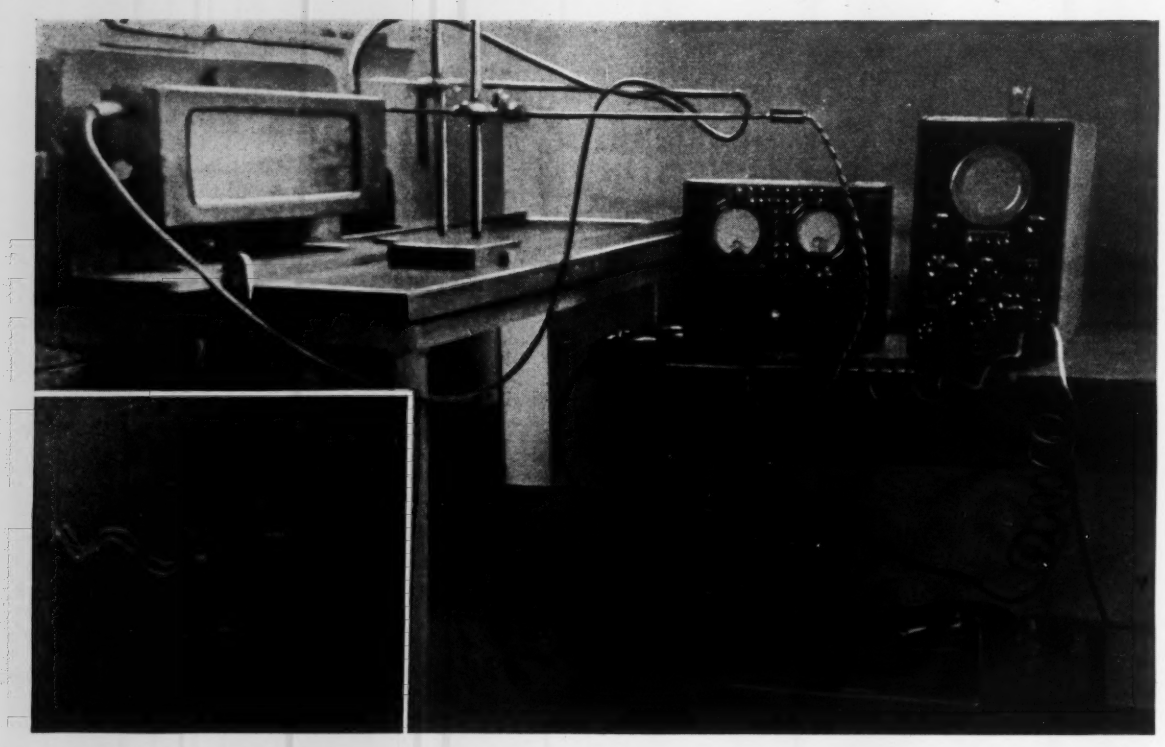


FIG. 11 DEMONSTRATING EFFECTS OF TURBULENCE WITH A HOT-WIRE ANEMOMETER
(Insert shows an oscillograph record of velocity variations in a von Kármán trail.)

of the latter is shown in Fig. 3. By a combination of these two methods, flow patterns through turbine blading (Fig. 13, *d* and *e*) can be studied.

(3) For towing models submerged to demonstrate certain three-dimensional flow conditions. Droplets of condensed milk suspended and mixed in the water and appropriately illuminated by narrow beams from a strong light source serve to make the flow visible. This method has been suggested and developed by Professor Bairstow of the City and Guilds College at South Kensington.

Experiments with smoke as well as with aluminum powder are subjected to limitations imposed by the low Reynolds numbers at which they have to be conducted. While this has to be kept in mind, it appears that the scale effect can be neglected in the early training in fluid mechanics, provided the influence of boundary-layer conditions and turbulence is given sufficient emphasis at a later time in the training.

PLACE OF THE WIND TUNNEL

For the same reason, it appears justifiable to demonstrate the basic phenomena of fluid flow pertaining to the interaction of fluid and immersed bodies at a sacrifice of dynamic similarity, since thereby the advantages of a great simplification and easy operation of the demonstration apparatus is gained. On this basis, the wind tunnels shown in Figs. 4 and 5 were built in adaptation of European patterns.[2] Fig. 4 shows an air jet of 25 in. diam and 30 fps velocity, produced by a $^1/_4$-hp 1800-rpm motor. This jet is intended primarily for exhibition purposes and can be operated safely by anybody. Little effort is made to equalize the velocities through the honeycomb. Nevertheless, the jet is adequate to demonstrate the effect of streamlining, comparative wind resistances, lift and drag characteristics, and similar basic facts.

[2] "Einführung in die Technische Strömungslehre," by Bruno Eck, Julius Springer, Berlin, 1936, vol. 2, pp. 7–12.

Equal velocity distribution and high velocities were the objectives when designing the jet shown in Fig. 5. The jet is 6 in. in diameter; its velocity 100 fps. The fan is driven by a $^1/_2$-hp 3400-rpm motor. This high fan speed, while permitting compact design, has the drawback of producing considerable noise. Low turbulence and nearly constant velocity distribution are achieved by countervanes, wire-mesh sieves, honeycomb, and a considerable contraction ahead of the nozzle. On account of the high velocity, little difficulty is experienced in measuring the pressures produced and the air forces acting on objects exposed to the air stream.

The demonstration wind tunnel has been used for a great variety of experiments. Fig. 5 shows the flow through a channel of variable cross section, in which the pressure variations are made visible by gages connected to numerous static-pressure connections. This apparatus is of great value in the discussion of the transformation of energy in fluid flow and of the steady flow relation.

A great variety of scales can be used for the measurement of forces produced by fluid flow, such as ordinary weighing scales, scales with coil or leaf springs, and others. Among these types, the hydrostatic scale[3] (Fig. 6) has been found useful. This scale is self-registering and produces minimum displacement of the object acted upon by the air forces. Further, its readings are not adversely affected by fluctuations of these forces. When, in addition to these merits, its simplicity, low price, and adaptability to most purposes in the laboratory are considered, it is seen that this type of scale commends itself for aerodynamic measurements. At first, these scales were likely to give faulty readings and required frequent calibration. As the causes of errors became known, however, the reliability of

[3] "Beschreibung des Aerodynamischen Instituts Aächen," by A. Gilles, Abhandlungen aus dem Aerodynamischen Institut an der Technischen Hochschule Aächen, Julius Springer, Berlin, 1931, vol. 10, p. 7.

their readings even during extended runs has become satisfactory.

The fluid-mechanics and aerodynamics laboratory of Case School of Applied Science has a Göttingen-type wind tunnel of 3 × 3 ft working section and 150 fps maximum velocity which was designed by P. E. Hemke. Since the wind tunnel is much in demand for laboratory tests, thesis work, and research investigations, its availability has been increased by the construction of exchangeable cradles. Models to be tested are mounted on these cradles outside of the wind tunnel together with scales and measuring instruments, and the cradles are placed in the tunnel only during the time of actual tests. Fig. 7 shows one of these wind-tunnel cradles on which is mounted a model propeller-testing stand for the measurement of power input, thrust, and efficiency at all normal operating conditions. In Fig. 8, another cradle is shown which has a moving belt approximating road conditions for testing automobile models.

EXPERIMENTS CONDUCTED BY STUDENTS OF AERODYNAMICS

An idea of the character and scope of student laboratory work can be given best by presenting a list of experiments conducted by the students taking aerodynamics. This list includes pressure and velocity measurements in the working section of the wind tunnel, directional calibration of a pitot tube, comparative drag measurements of various bodies of rotation, drag of strut profiles, pressure distribution about a cylinder, drag of a sphere, friction drag of a flat plate, hot-wire anemometer measurements, lift and drag of Clark Y airfoil, pressure distribution about an airfoil section, test of a model propeller, and test of airplane model. A few general comments and explanations in regard to this list may be in order. Aerodynamics, being a part of the mechanical-engineering curriculum, has been approached from the general angle, rather than from that of a specifically aeronautical

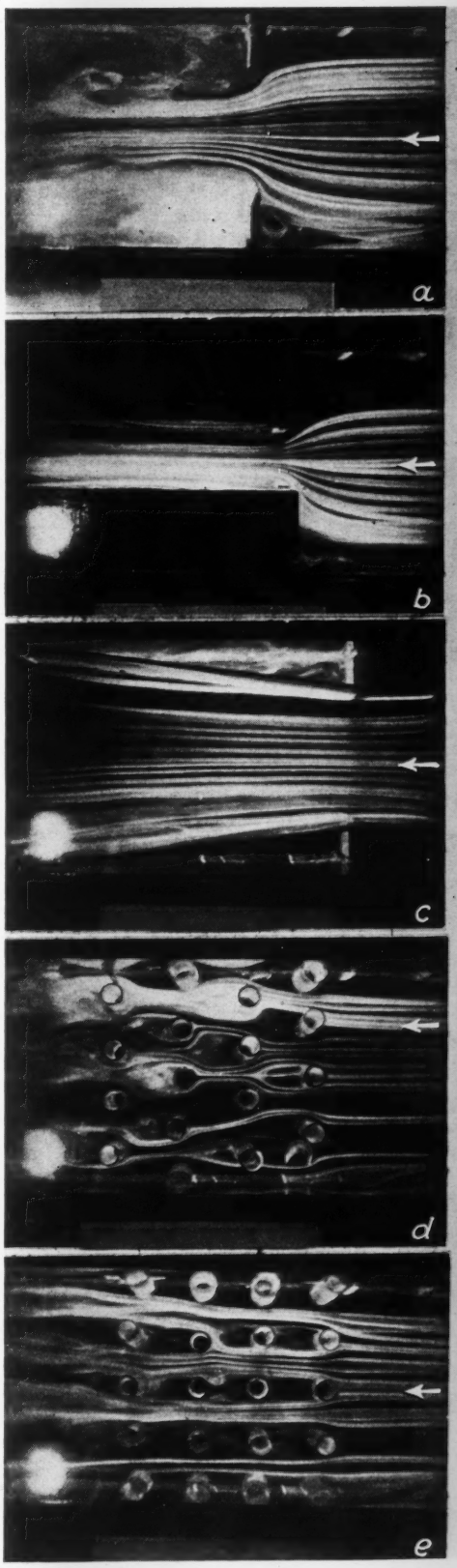


FIG. 12 SMOKE PICTURES OF FLOW PATTERNS
(Reading from the top downward, these are *a*, sharp-edged orifice; *b*, inlet of tube; *c*, diffuser; *d*, tube bank with staggered arrangement of tubes; and *e*, tube bank with tubes in line.)

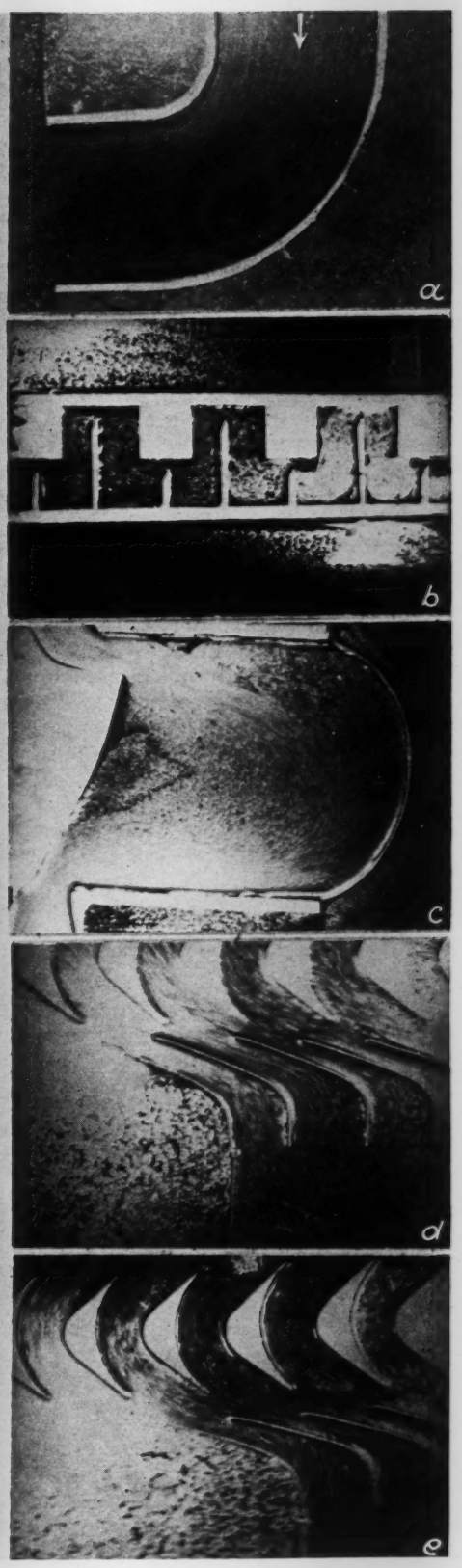


FIG. 13 ALUMINUM-POWDER FLOW PICTURES
(Reading from the top downward, these are *a*, elbow; *b*, labyrinth seal; *c*, port scavenging; *d*, flow through turbine nozzles; and *e*, flow through turbine buckets.)

science. It is regarded as a logical continuation of the introductory course of fluid mechanics, with such specialization on incompressible fluids and on fields of practical application as was deemed advisable. In developing the laboratory schedule, therefore, preference has been given to the basic experiment rather than to the specific application. This rule has not been followed strictly, however, since it was felt that certain aeronautical subjects have attained general importance to such a degree that they should be familiar to the student in mechanical engineering. The propeller test, for instance, was included because of the increasing importance of this element for transportation. At the same time, propeller performance is typical of the characteristics of the large and important group of steady-flow machines that have essentially the same performance curves as the propeller. The experiment, appropriately coordinated with the class work, is also an invaluable aid to the student in his understanding of the propeller theory.

In view of these facts, it is, therefore, not difficult to be reconciled to the large-scale effect of model propellers, which show efficiencies of the order of 60 per cent as compared with 85 per cent of the full-size propeller.

Fig. 9 shows the setup for the sphere test in the wind tunnel, and also the results obtained, plotted in the usual manner on a graph board of blackboard size. This board was constructed from a piece of etched plate glass, back of which can be placed graph sheets of normal metrical divisions of logarithmic divisions. The board has aided to a great extent in making the student familiar with the nature of the functional relations existing in fluid dynamics and with their representation in logarithmic form plotted against Reynolds' number. Comparison of the measured results with published values stimulates discussion of the causes for the discrepancies and of the numerical influence of secondary factors.

A pipe used for pressure-drop measurements mounted on the flow tank, together with the necessary instruments, is shown in Fig. 10. This illustration also shows a plot of the pressure-drop coefficients measured. It serves to show how instruction by visual methods can be applied to advantage in the introductory course in fluid mechanics.

In developing experimental facilities for demonstrating the nature of turbulence and boundary-layer effects, recourse was made to the possibilities offered by the hot-wire instrument. Even though visual presentation of turbulent flow obtained on the screen of a cathode-ray oscillograph from a hot-wire instrument cannot be more than of quantitative value, its educational value is not to be overlooked. For, it is a fact that, at the instant a quantity can be measured, it ceases to be an academic concept in the mind of the student and emerges as a definite physical reality. These considerations have led to the development of the hot-wire instrument, shown in Fig. 11, together with the oscillograph. The wave on the oscillograph screen shown on the insert is produced by the vortices of the von Kármán trail behind a cylindrical body.

A survey of the equipment and facilities of a fluid-mechanics laboratory would be incomplete without a word of emphasis in regard to the importance of photography in this branch of engineering training. To illustrate this point, several photographs of flow by the smoke and the aluminum-powder methods, Figs. 12 and 13, respectively, which have been obtained from tests in the laboratory and are used as an aid in the instruction in fluid mechanics, are shown here.

Photograph by John P. Mudd for The Midvale Co.

Technique of BURNING FUEL OIL *and* NATURAL GAS

By F. G. PHILO

SOUTHERN CALIFORNIA EDISON COMPANY, LTD., LONG BEACH, CALIF.

LONG-DISTANCE transmission of natural gas together with new sources of supply have provided another fuel for a number of the larger central generating stations. In most cases, the use of such fuel permits an increase in the annual load factor of the gas-transmission facilities which has resulted in a price that is attractive to all concerned.

The Long Beach steam station of the Southern California Edison Company, Ltd., is a typical example of this. Since its initial operation in 1911, the station, with a present capacity of 415,000 kw, has been equipped for oil fuel. Prior to 1922, oil fuel was used exclusively. Since then, natural gas has displaced fuel oil as the normal fuel supply until, at present, the latter constitutes less than 1 per cent of the annual fuel used. The technique of handling oil and gas fuel and the equipment used in this station represent, in most ways, the latest methods in central-station practice and are largely used as the basis for this paper.

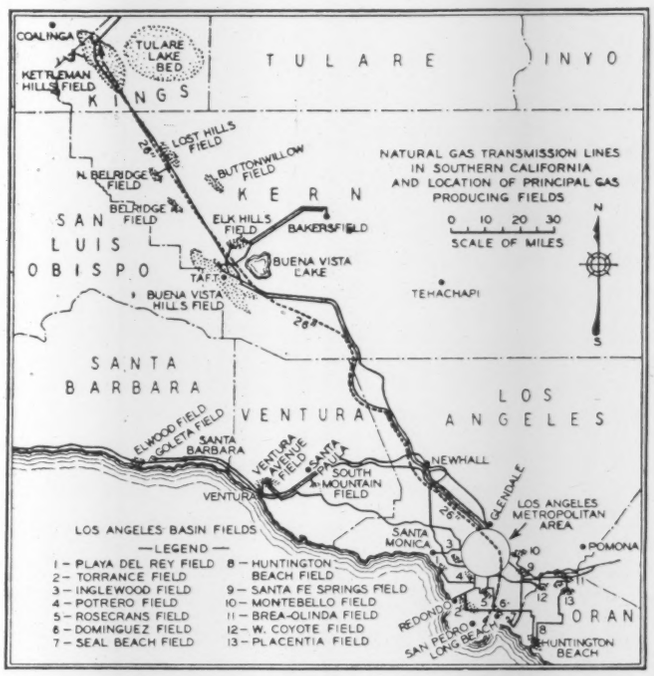


FIG. 1 HIGH-PRESSURE GAS-TRANSMISSION LINE FROM KETTLEMAN HILLS TO LONG BEACH STEAM STATION

NATURAL GAS

The normal source of gas-fuel supply is the Kettleman Hills field, approximately 208 miles northwest of Long Beach, which is connected with the station by a high-pressure gas-transmission line as shown in Fig. 1. This line is constructed of 26-in. outside diameter steel pipe with electric-welded joints throughout the greater portion of its length. Leaving the rugged section of the Kettleman Hills district, the line traverses the southwest corner of the San Joaquin valley and, for approximately 40 miles, crosses the mountain range between that valley and Southern California. The upper portion of the line taps four producing oil fields in addition to Kettleman Hills. The project also includes a submarine crossing of 800 ft near its southern terminus.

The gas used is "dry," having previously passed through gasoline-recovery plants which, in addition to recovering casing-head gasoline, thoroughly free the gas of water, oil, and sand. When the gas leaves the field, its pressure is approximately 400 lb gage, but, before entering the Los Angeles territory, the line passes through a control station at Glendale where the pressure is regulated to give a delivery pressure of about 150 lb gage at Long Beach for all flows up to the full capacity of the line which is 130 million cu ft per day. On entering the station property, a further reduction in pressure to 25 lb is made, after which the gas is metered and distributed to the boiler rooms, being further reduced to a boiler-room supply pressure of 9 lb before entering the buildings.

This arrangement has been satisfactory from an operating standpoint but it is felt that a future installation would carry the 25-lb pressure to each boiler where it would be reduced by individual boiler regulators to 8 to 10 lb, before reaching the burner-header regulating valves. This would insure proper header pressure at all boilers, regardless of changes in loading, and would decrease materially the size of the gas lines within the station.

Before going to the regulators, the high-pressure gas is passed through a 13 ft × 6 ft 6-in. cylindrical separator equipped with suitable traps designed to remove any water or oil that might be carried in the gas. Measurement is accomplished by orifice meters in Commercial Iron Works orifice fittings, three 16-in. and one 12-in. tube being used to secure accurate metering at all capacities. Recording thermometers are located in the meter tubes to record the flowing temperature of the gas fuel. Specific gravity of the gas is recorded by a Ranarex density recorder, and a continuous record of the heating value per cubic foot is secured from a Thomas recording calorimeter. Both gravity and heating value are variables, depending somewhat on each other. Occasionally, gas is received with a heating value as high as 1250 Btu per cu ft, and, at times, it may fall to around 1050 Btu, the yearly average being about 1135 Btu per cu ft. The gas is purchased on a cubic-foot basis referred to 60 F and a pressure base of 14.73 lb per sq in. absolute. Metering is done in accordance with the latest data based on the American Gas Association's Gas Measurement Report No. 2, dated August,

Presented at the Spring Meeting, Los Angeles, Calif., Mar. 23–25, 1938, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

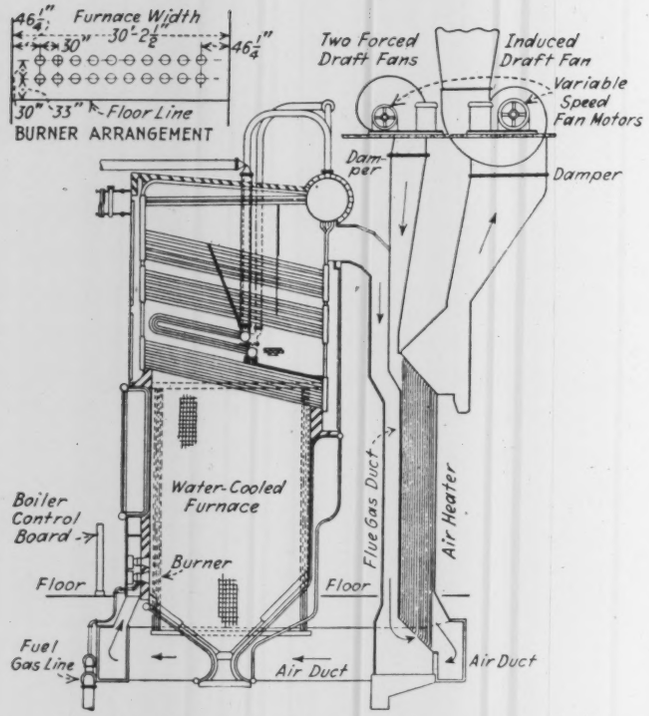


FIG. 2 CROSS SECTION OF BOILER NO. 50 AND RELATED EQUIPMENT LONG BEACH STEAM STATION

1935. Such measurement requires recording the static and differential pressures across carefully calibrated orifices and tubes, determination of the flowing temperature, specific gravity, Reynolds' number, and supercompressibility or deviation from Boyle's law of the gas being measured, as well as inclusion of an expansion factor for behavior of the gas in its flow through the orifice. Notwithstanding the seeming complexity of these quantities, the calculation of gas fuel is not an arduous task once the proper tables and curves are compiled and can be done with perhaps a greater accuracy than for any other fuel. The record is continuous and shows each variation or change in operation affording unusual possibilities for plant adjustments to secure maximum economy.

Fig. 2 shows a cross section of one of the 34,160-sq ft boilers, including the arrangement of gas supply and burners. Each of the six boilers in this plant is equipped with 20 combination Peabody oil-and-gas burners of the type shown in Fig. 3, which are designed to deliver 30,000 cu ft of gas per hour each with a pressure at the burner of 3 lb. They are supplied from a 14-in. outside diameter gas header located below the firing floor where the gas pressure is controlled by chronometer valves operated from the Bailey automatic control system. Individual burners are supplied through risers from this header with rising-stem gate valves in the risers immediately above the header and plug cocks on the firing floor for rapid control of the gas to each burner. The boiler shown has been tested at a maximum output of 450,751 lb of steam per hour representing 413.2 per cent of its rated capacity of 3416 boiler hp.[1]

When burning gas fuel, all burners are fired for all loads, it being possible to reduce the gas input safely to a point where the boilers are generating practically no steam. Some minor changes in the combustion-control system make possible an increase in the fuel and air supply on the six boilers from minimum to maximum in 45 sec, enabling the 100,000-kw turbine units to accept instantly and maintain a load of 85,000 kw from an initial load of only 1000 kw. This feature converts a plant that was primarily designed for base-load operation into an excellent stand-by reserve for the various hydroelectric plants on the system during seasons when little or no steam output is required. While a large number of burners insures even distribution of fuel in the furnace, their use complicates construction of the surrounding furnace lining and multiplies the valves that must be operated when changing fuels. Recently burners of much larger capacity have been developed, and perhaps six burners would be ample for a boiler of this size.

[1] "Comparative Performance of a Large Boiler Using Oil and Natural-Gas Fuels," by F. G. Philo, Trans. A.S.M.E., vol. 54, 1932, paper FSP-54-11.

FUEL OIL

It is usually impractical to store gas on the station property in sufficient quantities to be of use should an interruption in supply occur. Although experience has shown that existing high-pressure gas-transmission lines are reliable and free from trouble, oil is usually used as a reserve fuel and sufficient quantity stored on the premises to protect the station from failure of the gas supply or its diversion to other uses in cold weather, the quantity stored being generally determined by delivery facilities. The Long Beach station is connected by pipe line to a near-by refinery and ordinarily carries sufficient oil in storage for approximately 4 days' supply at normal full load of the 345,000-kw capacity in modern equipment installed in plants 2 and 3.

Because of fire hazard, the storage tanks are usually located as far as possible from other structures and carefully protected, both for control of fire and spread of burning fuel should fire occur. The tanks are often carefully "strapped" at installation and used for measurement of oil purchased, billing being rendered on the volume received as shown by "rodding" after correction is made for temperature. Fuel oil is ordinarily purchased by the barrel of 42 gal with an approximate average weight of 8 lb per gal or 336 lb per bbl, varying somewhat with the specific gravity. Measurement is referred to a temperature of 60 deg F, corrections for volume being made in accordance with the supplement to the National Bureau of Standards Circular No. 154. A limit of 2 per cent is usually placed on water

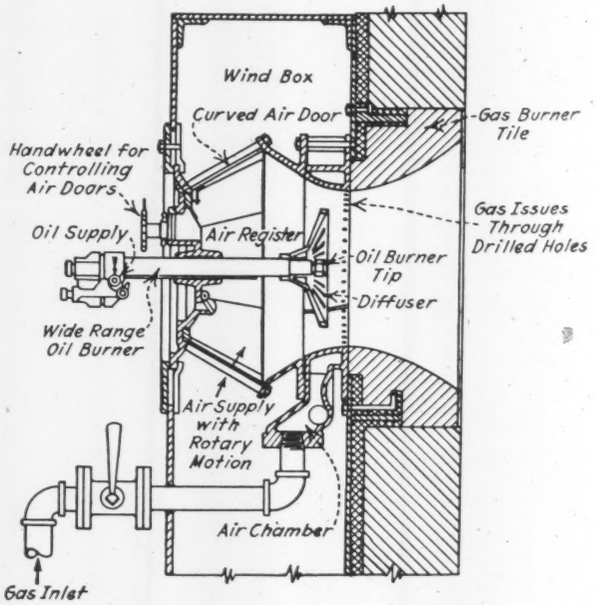


FIG. 3 COMBINATION GAS-AND-OIL BURNER AS INSTALLED AT LONG BEACH STEAM STATION

and sediment, and it is often specified that the gravity shall not be less than 14 deg A.P.I. at 60 F. Heating value is reported in Btu per pound, a usual value being 18,600 or 6,250,000 Btu per bbl, making 4.5 bbl of oil equivalent to a ton of ordinary coal. The heating value per barrel does not usually vary greatly for the ordinary grades of fuel oil since the lighter oils generally have a higher heating value per pound; however, specification of heating value per pound may require the addition of lighter and more costly fractions which may correspondingly reduce the Btu per barrel and per dollar.

Practically all crude oil is refined. Formerly, the lighter fractions such as gasoline, naphtha, and kerosene were distilled off in one large "cut," and the remainder, known as straight-run fuel oil, used as fuel. In later years, the introduction of cracking processes in the refinery has made it possible to rearrange the molecular structure of oils under high temperatures and pressures so that more gasoline and other desired fractions can be recovered, leaving a wide range of products all the way from fuel oil and "Dubbs" residue down through refinery wastes and acid sludge to petroleum coke, all of which are available for fuel either separately or blended to secure certain characteristics. Nearly all fuel oils today contain varying proportions of these cracked residues, and it is a distinct possibility that in the near future all petroleum fuel for industrial use will be 100 per cent cracked fuel.

The principal concern of the central station regarding fuel oil is in securing the proper number of available heat units for the money expended and an oil of such temperature-viscosity characteristics that it can be heated to give viscosities suitable for pumping and atomizing without leaving excessive deposits in heating equipment and lines. It should not contain foreign matter that would cause deterioration of equipment or refractories. Accepted maximum viscosities for pumping and atomization are 4000 and 150 sec Saybolt Universal, respectively. In the most commonly used oils, these correspond to temperatures of 80 to 90 F for pumping and 195 to 200 F for atomizing. The general custom is to carry the final oil temperature at between 225 and 250 F.

It is desirable to provide ample heating capacity for oil in storage, the accepted method being by steam, either through coils in the tank or by heat exchangers in the adjacent lines. In cold climates, it may be desirable to insulate the lines between the storage tanks and the plant, and in nearly all cases fuel-oil transfer pumps will be required to speed up delivery even though gravity feed be used from the storage to the burning tanks. While centrifugal pumps are sometimes used for this service, displacement pumps are generally preferred as their performance is less affected by the varying viscosities caused by temperature changes in the stored oil. A positive pump-suction pressure is desirable in both cases, and "swing" suctions are sometimes provided in all oil tanks to avoid drawing sand and other residue from the tank floor.

SERVICE TANKS

Comparatively small service or burning tanks are usually installed adjacent to the station. These receive their supply from the storage tanks and should be installed in duplicate, each tank holding not less than enough oil for 8 hr full-load operation of the station, oil being withdrawn from one while the other is being filled. These tanks are carefully calibrated and the hourly station use determined therefrom by gaging. Oil in the burning tanks is often heated by returning a portion of the oil as heated for atomization, although heating coils are sometimes used. Since the burning tanks are ordinarily located underground the high-pressure or burning oil pumps would normally have a suction lift if located within the main structure. In constructing the Long Beach steam plant No. 3, a separate concrete fuel-oil pump house was installed with the pump elevations depressed to give a positive suction head. Steel flanges and fittings corresponding to the standard 125-lb cast-iron pattern were used throughout for the oil lines between the service tanks and the pumps. It is considered advisable to use this standard or the alternate of welded fittings also on all gas lines within the station.

Fire protection for both the burning tanks and the fuel-oil pump rooms is provided by smothering lines supplied with steam at a reduced pressure of 125 lb from the main boiler room. This system also supplies steam to the heaters under thermostatic control for heating the oil to approximately 250 F for the proper atomization. Drips from the heaters are returned through coil drainers to heat exchangers located on the cold oil lines before the heaters and thence to detector tanks, where the drips can be inspected before return to the boiler feed system. Should the drips be contaminated by oil leakage from the heaters, a weir is provided in the detector tank where, by raising the water level slightly, surface accumulations of oil can be skimmed off to the dirty-oil sump.

In the modern central station it is highly important to reduce make-up water requirements. Average make-up requirements in this station for a 75 per cent load factor are about 0.5 per cent of the total boiler feed requirements. Steam required for heating the necessary fuel oil from 70 to 250 F is also approximately 0.5 per cent, and, therefore, make-up requirements would be doubled if the drips from the fuel-oil heater should be discarded.

BURNER SUPPLY LINES AND DESIGN

Fuel-oil suction lines to the high-pressure pumps should be of ample size. In this station, they are 14 in. and are installed in duplicate. Duplicate simplex strainers are located ahead of each high-pressure fuel-oil pump, which is of the double-screw positive-displacement type and discharges to headers from which the heaters and heat exchangers are manifolded so any piece of equipment can be disconnected without interruption of service. Relief valves on this header are set at 275 lb, and a second, valve-controlled, relief valve set at 50 lb is provided for circulating oil through the system when gas fuel is used. A second set of duplex strainers is located on each of the 6-in. high-pressure oil headers leading to the boiler rooms. Remote-control pressure regulators are also installed in these lines with the control element located in the boiler room, insuring an even oil pressure at all loads. This pressure can be varied at the firing station as desired. An extensive drain system is provided so that all equipment can be easily drained to clean oil sumps, with provision for returning the drained oil to the system.

Leaving the fuel-oil room, duplicate 6-in. high-pressure oil headers are carried beneath the firing aisle of the boiler room from which take-off lines are led to individual supply headers located on the boiler fronts above the burners. Individual burner-supply lines are taken from the supply headers, the return connections from the burners going to a return header that is located adjacent to the supply header. Return header pressure is under both manual and automatic control, the oil feed to the furnace being controlled by return rather than by supply pressure, the maximum supply to the furnace being obtained when the return valve is closed.

Variations in the ratio of supply to return pressure cause changes in the angle of spray from the burners which is sometimes objectionable. Reduced fuel consumption in the furnace obtained by by-passing oil from the burner tip requires circulation of more than full-load requirements of oil. A recent

TABLE 1 ANALYSES AND COMBUSTION CHARACTERISTICS OF REPRESENTATIVE GAS AND OIL FUELS

Gas Analysis	
Constituent	Per cent by volume
Methane, CH_4	74.7
Ethane, C_2H_6	23.7
Oxygen, O_2	0.1
Nitrogen, N_2	1.4
Carbon Dioxide, CO_2	0.1
Total	100.0

Heat value at 30 Hg and 60 F, saturated, 1205 Btu per cu ft as determined by Thomas calorimeter. Specific gravity (calculated), 0.681.

Fuel-Oil Analysis	
Constituent	Per cent by weight
Carbon, C	86.50
Hydrogen, H_2	11.00
Nitrogen, N_2	0.29
Sulphur, S	0.94
Oxygen, O_2	1.02
Moisture, H_2O	0.20
Ash	0.05
Total	100.00

Heat value, by test, 18,600 Btu per lb. Gravity, 17.9 deg Bé. Flash point, 198 F.

Gas Analysis by Volume Converted to Analysis by Weight

Constituent	Analysis by volume, per cent	Molecular weight	Weight of molecular fraction	Analysis by weight, per cent	Carbon, lb: Per lb of constituent	Carbon, lb: Per lb of fuel	Hydrogen, lb: Per lb of constituent	Hydrogen, lb: Per lb of fuel	Nitrogen, lb per lb of fuel	Oxygen, lb: Per lb of constituent	Oxygen, lb: Per lb of fuel
CH_4	74.7	16.032	1197.59	61.21	0.7485	45.82	0.2515	15.39	..	....	....
C_2H_6	23.7	30.048	712.14	36.40	0.7987	29.07	0.2013	7.33	..	....	....
O_2	0.1	32.000	3.20	0.16	....	....	....	....	....	1.0000	0.16
N_2	1.4	28.016	39.22	2.01	....	....	....	....	2.01	....	....
CO_2	0.1	44.000	4.40	0.22	0.2727	0.06	....	....	..	0.7273	0.16
Total	100.0		1956.55			74.95		22.72	2.01		0.32

Combustion Characteristics of Gas and Oil Fuels

Constituent	Per cent by weight: Gas	Per cent by weight: Oil	Air requirements, lb: Theoretical per lb of constituent	Air requirements, lb: Per lb of fuel: Gas	Air requirements, lb: Per lb of fuel: Oil	Theoretical Combustion Products: CO_2, lb: Per lb of constituent	CO_2, lb: Per lb of fuel: Gas	CO_2, lb: Per lb of fuel: Oil	Moisture, lb: Per lb of constituent	Moisture, lb: Per lb of fuel: Gas	Moisture, lb: Per lb of fuel: Oil	Nitrogen, lb: Per lb of constituent	Nitrogen, lb: Per lb of fuel: Gas	Nitrogen, lb: Per lb of fuel: Oil	SO_2, lb: Per lb of constituent	SO_2, lb: Per lb of fuel: Gas	SO_2, lb: Per lb of fuel: Oil	Total
C	74.95	86.50	11.52	8.63	9.96	3.67	2.75	3.17	..	..	..	8.85	6.63	7.66	..	..	..	....
H_2	22.72	11.02	34.29	7.79	3.78	..	..	..	8.93	2.03	0.98	26.36	5.99	2.91	..	..	..	....
N_2	2.01	0.29	0.00	0.00	0.00	..	..	..	..	..	..	1.00	0.02	0.00	..	..	..	....
O_2	0.32	1.20	−4.32	−.01	−.05	..	..	..	..	..	..	−3.32	−.01	−.04	..	..	..	....
S	0.00	0.94	4.31	0.00	0.04	..	..	..	..	..	..	3.31	0.00	0.03	2.00	0.00	0.02	....
Ash	0.00	0.05	0.00	0.00	0.00	..	..	..	..	..	..	0.00	0.00	0.00	..	..	..	....
Total	100.00	....	....	16.41	...	..	..	..	..	..	..	....	....	....	..	..	..	17.41
Total	....	....	....	...	...	..	2.75	..	..	2.03	..	....	12.63	...	..	0.00	..	17.41
Total	....	100.00	....	...	13.73	..	..	..	..	..	..	....	....	....	..	..	..	14.73
Total	....	....	....	...	...	..	..	3.17	..	..	0.98	....	....	10.56	..	..	0.02	14.73

development includes a regulating valve installed either in or between the burner supply and return headers and connected to maintain a constant differential between the supply and return headers giving a constant angle of spray from the burner tips at all loads and also approximately a constant oil flow through the system at all loads. The general arrangement of the fuel system as installed at the Long Beach steam station is shown in Fig. 4.

Early oil burners were of the steam-atomizing type, using steam at about 150 lb pressure and oil at a pressure of approximately 40 lb and a temperature of 140 to 150 F. Although these burners were satisfactory for early boiler installations, their capacity was limited, and they required approximately 3 per cent of the steam output of the boiler to atomize the oil. They were later almost entirely superseded by the larger capacity and more efficient mechanical-atomizing burner. Recently, a high capacity steam-atomizing burner has been developed which is interchangeable in the same air register with mechanical burners and is reported to use from 0.6 to 1.3 per cent of the steam generated for atomization and to have a wide capacity range. The more commonly used mechanical-atomizing oil burners can be combined in the same air register with natural-gas and powdered-coal burners, and the fuels can be used interchangeably. Details of a mechanical oil-burner tip assembly for use on a return oil system are shown in Fig. 5.

When changing from oil to gas fuel, the oil burners should be either immediately removed and cleaned or thoroughly scavenged with steam or air to prevent accumulation of carbonized deposits in the small holes and slots in the burner tips. When

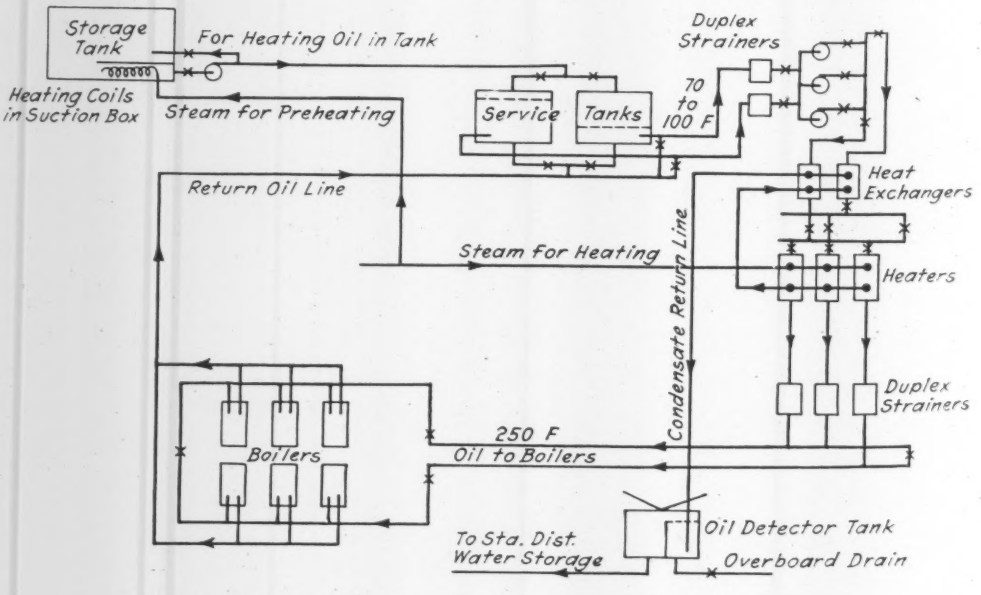


FIG. 4 FUEL-OIL SYSTEM, PLANT NO. 3, LONG BEACH STEAM STATION

burning other fuels, the oil-burner assembly including the air-diffuser plate is pulled back in the air register to protect it from the heat of the furnace.

Early gas burners were constructed on the principle of the Bunsen burner, a considerable number being located in the furnace floors or walls and the gas being burned at a pressure of 1 lb or less. The modern gas burner usually consists of a circular ring or box placed on the inner side of the air register in which small holes are drilled at a suitable angle to permit the gas to flow into and become thoroughly mixed with the incoming turbulent air stream. Originally, the gas-burner ring was a one-piece casting which tended to warp and distort under the action of the furnace heat. More adequate provision for expansion has since been provided by making the gas rings sectional, and they are now a reliable and trouble-free piece of equipment.

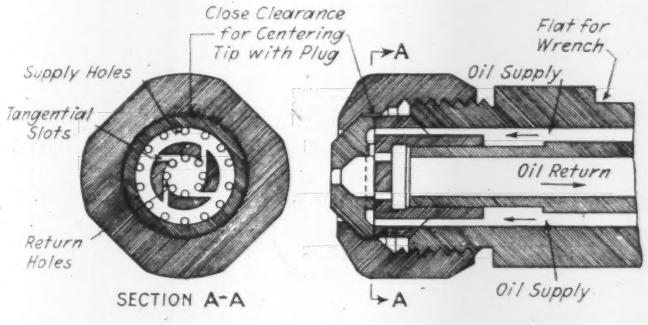


FIG. 5 WIDE-RANGE MECHANICAL ATOMIZER

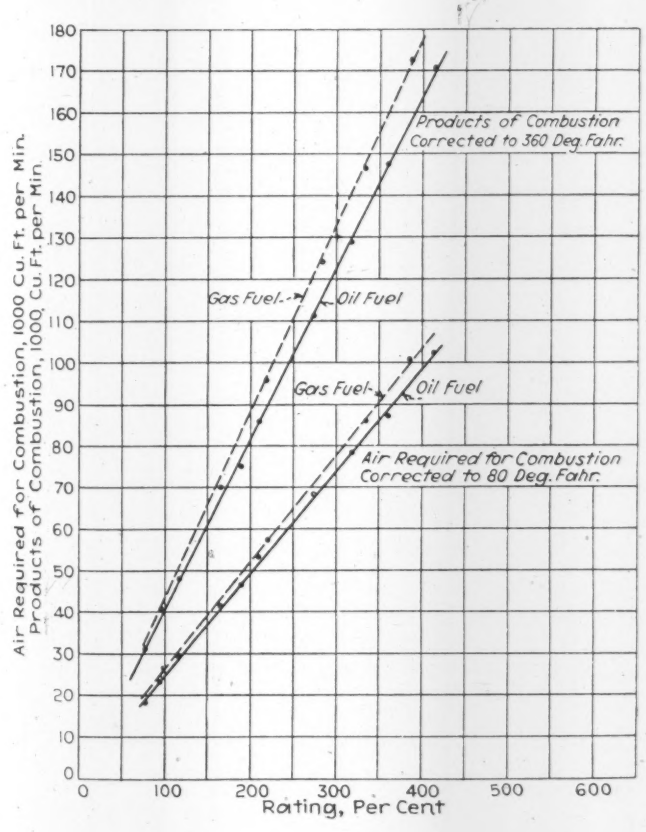

Air Required for Combustion, 1000 Cu. Ft. per Min.
Products of Combustion, 1000 Cu. Ft. per Min.
Products of Combustion Corrected to 360 Deg. Fahr.
Gas Fuel
Oil Fuel
Gas Fuel
Oil Fuel
Air Required for Combustion Corrected to 80 Deg. Fahr.
Rating, Per Cent

FIG. 6 AIR REQUIRED AND PRODUCTS OF COMBUSTION, OIL AND GAS FUELS

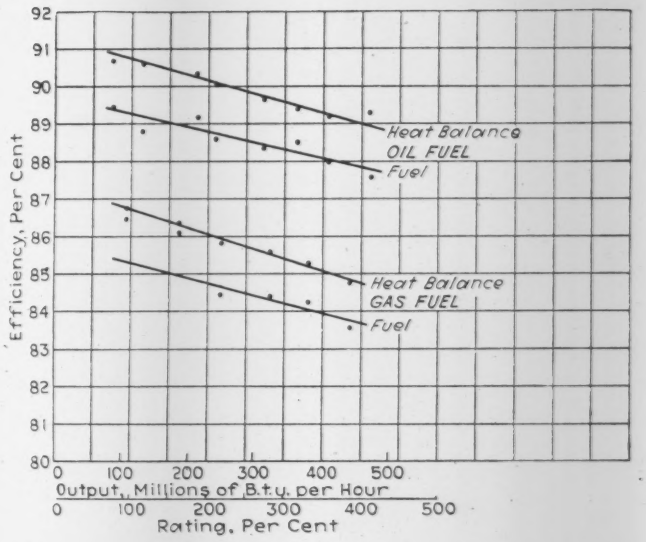


FIG. 7 COMBINED EFFICIENCIES OF FURNACE, BOILER, SUPERHEATER, AND AIR HEATER, OIL AND GAS FUEL

COMBUSTION DATA

Analyses of representative samples and combustion data for fuel oil and natural gas are given in Table 1. Gas samples are reported on a volumetric basis, and the analysis by volume has been reduced to one giving percentage by weight to compare the combustion characteristics of the two fuels. It will be noted that the ratio of carbon to hydrogen is considerably higher in oil than in gas fuel, while the air required and the water vapor formed are considerably less. With the same flue-gas temperature this will show about 4 per cent greater stack losses for gas than oil. While this should be considered when comparing the purchase price of the two fuels, actual losses in the use of gas fuel above fuel oil are usually less than the theoretical, because gas fuel deposits little or no soot on the boiler heating surfaces, soot blowing is not required, and the average heat transfer is better.

Air requirements and products of combustion of oil and gas fuels as secured from test data on the boilers described in this paper are shown in Fig. 6, the comparative tested efficiencies being shown in Fig. 7. It is interesting to note, in the latter illustration, the comparison of heat-balance efficiencies of the two fuels, as calculated from their analyses and the exit-gas temperature, with the tested values obtained by weighing the oil and metering the gas. Since the heat-balance method includes all radiation and unaccounted for losses, it is felt that the average differences of about 1.25 per cent between the two methods represents closely the radiation losses from the boiler tested. With a fuel of uniform compostion, the heat-balance method provides a rapid and reasonably accurate method of checking boiler performance at any time.

When burning gas fuel, practically no flame shows in the furnace and temperatures are low, seldom exceeding 2400 F. Refractory maintenance is much reduced, radiant heat is less, and more convection heat is available for the boiler heating surface. Under certain conditions with convection-type superheaters, this will result in higher superheated-steam temperatures with gas than with oil. These relations are shown in Figs. 8 and 9.

In the operation of large boilers, such as those installed in this station, great dependence is placed on instruments and an ample supply is provided. Steam output and air flow for each boiler are recorded by a Bailey meter which also functions as a

part of the automatic combustion-control system. Gas fuel is metered by a Westcott orifice meter and Builders Iron Foundry venturi meters measure the flow of fuel oil and boiler feed water. A six-point Leeds & Northrup temperature recorder is installed for recording feedwater and steam temperatures as well as flue-gas and air temperatures throughout the boiler system. Multipointer Bailey draft gages indicate drafts in the air and gas passes and fuel-gas pressure at the burners. Indicating gages are provided for boiler and fuel-oil pressures and a Foxboro recording water-level gage is also included. A Mono duplex flue-gas recorder automatically analyzes the flue gases, burning a check sample after each analysis to indicate and record unconsumed combustibles. Controls for the fans and combustion control are also located on these boards, the equipment being set to burn both gas and oil fuel with 15 per cent excess air which is a good operating value.

This boiler room, which is located on the third floor of the station building, with tiled floors that are regularly waxed and polished, large windows and excellent lighting, and a general atmosphere of cleanliness and comfort is a great change from the basement stokeholes of other days. The change in the type

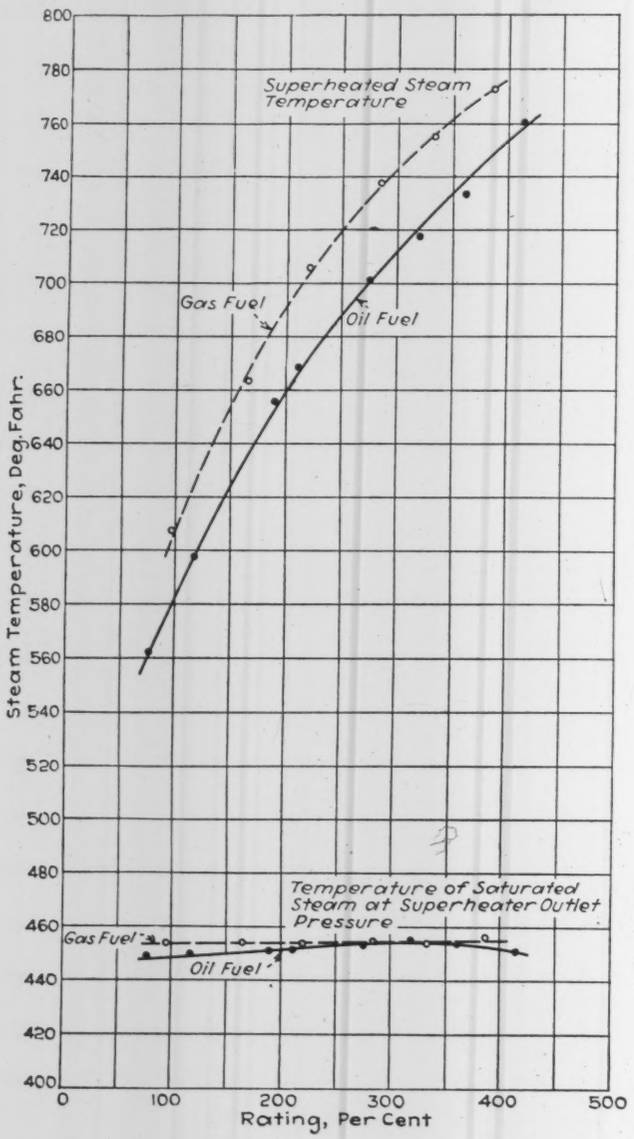


FIG. 8 SUPERHEATED-STEAM TEMPERATURES

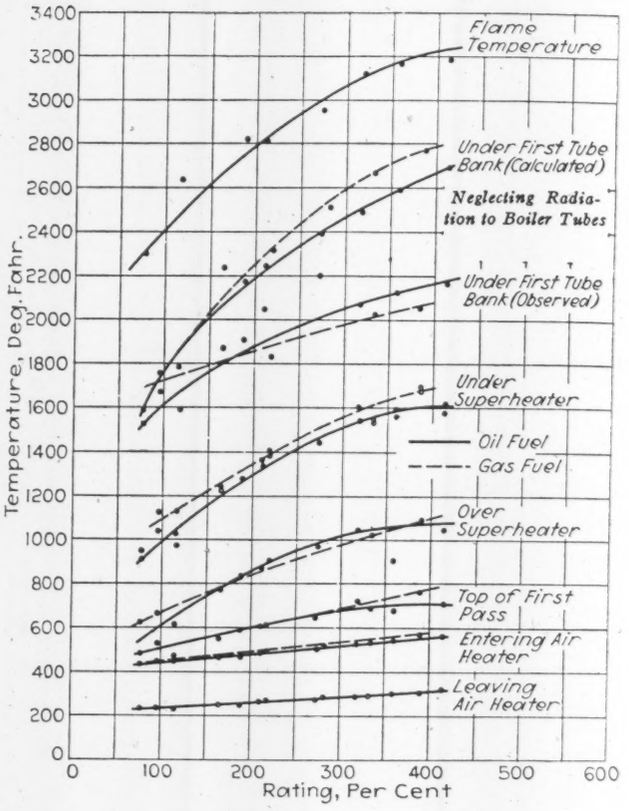


FIG. 9 DISTRIBUTION OF GAS TEMPERATURES THROUGHOUT FURNACE, SUPERHEATER, BOILER, AND AIR HEATER

of men who operate such equipment has been perhaps greater. The physical effort required is no longer great and the number of operators has been reduced until four men per shift are considered adequate to operate the six boilers, supplying steam for 200,000 kw and care for the equipment described in this paper. However, competent and efficient handling of the type of equipment involved makes it imperative to employ only alert and intelligent operators.

The boiler room and its related equipment afford the most direct and attractive possibilities for reducing production costs in the fuel-electric generating station. Careful study of its design and construction together with thorough training of its operators are sure to pay handsome dividends through the life of the station. Cleanliness of boiler and other heat-transfer equipment, constancy of fuel composition, and ease of measurement and manipulation permit rather ideal control of boiler-plant operation with the use of gas and oil fuels.

So-called imperfect distribution or need of most things by most people is nothing new. What is comparatively new is the general recognition of it, the quickening of the public conscience. Whereas, until 50 or 100 years ago, none but a few philanthropic persons inconvenienced themselves over the discomforts and miseries of the vast majority, a general and practical solicitude for less fortunate members of the respective communities is now prevalent in all parts of the civilized world. Still greater improvement will be best effected by following the definite amelioration already noted rather than by scrapping everything and starting afresh.—From the Twentieth Streatfeild Lecture before the Institute of Chemistry by Sir Martin Forster, *The Engineer*, Dec. 17, 1937, p. 691.

Some Trends in
WAGE INCENTIVES

By MERRITT LUM

VICE-PRESIDENT, GOODWIN SYSTEM, INC., NEW YORK, N. Y.

"WELL, WE'RE ready to sign the agreement, if you'll agree to cut out all wage incentives." A labor leader is speaking. It is the end of a long drawn-out session between representatives of management and representatives of labor. The matter under consideration is the agreement which is to represent the working arrangements for the following year. Wages, working conditions, seniority rights—all subject to negotiation and a final meeting of the minds. But wage incentives—nothing doing! They are out.

LABOR OPPOSITION

Lest you think I am an alarmist in painting such a picture, may I refer to a cross-section survey of industry, recently made, that revealed a surprisingly large number of companies in which labor agreements involved "thumbs down" on incentives. Up to date this has been a minority experience but has presented a positive problem.

To indicate the difficulty, I quote from the statements of several companies who answered the question: "What has been the union attitude toward wage-incentive systems?"

"Unions would rather see all incentive systems abolished."

"Unions indicated clearly that they were not interested in any form of premium system, but only in hours of work and hourly rates of pay."

"Union attitude understood to be opposed to incentives."

"Prior to signing of agreement we used an individual bonus system. This was eliminated and all factory employees were placed on daywork at the time agreement with C.I.O. was signed."

"Radicals want work and pay with no measurements."

"Four years ago we had a task and bonus system and the union asked for straight piecework."

"Unions asked that all incentive work be on a straight piecework basis."

The reality of the opposition of organized labor to incentive systems has been confirmed by contact with organizations that specialize in the installation of incentive systems. In one state,[1] this opposition has acquired a momentum sufficient to secure introduction into the state legislature of a bill which would bar incentive systems from use by industries in the state. It is interesting to note the provisions of this bill from which quotation is made as follows:

> No employer shall engage employees to work under a group system, standard time system, or other wage-incentive system plan of wage payment usually referred to as "point premium plans."
>
> Every employer shall be required to pay his employees by a system that will enable each employee to know the exact earnings of each workday on a straight time unit basis or by a unit piecework basis.
>
> No employer shall by contract or any other means with an employee secure exemption from the provisions of this section.

Hence, trend No. 1 in incentives, it seems to me, is a growing resistance to incentives from organized labor.

LABOR PHILOSOPHY

Why is this so? Most of us have regarded the incentive method of wage payment as permanent and inherent in American industrial operations. How, then, can it come to pass that a primary partner in the beneficial effects of incentives should, after all these years, decide to wash its hands of the subject?

To answer this question, we must turn to the underlying philosophy of organized labor. Involved in the appeal of organized labor to the masses of workers is the fundamental offer of higher wage rates or shorter hours or both. And to the mind of the worker, the union offer of, and delivery of, higher wage levels must be made clear, simple, and specific, if the union is to get by.

A wage-incentive system that is at all complicated in its comparison of the "before and after" return to the worker defeats this appeal. Where the labor leader feels at all handicapped in his tactics by a wage-incentive system, we are apt to have his opposition.

Now, by this, I am not inferring that organized labor as a whole, or officially, will take a definite position against wage incentives. I believe that there is too much common sense at labor headquarters not to realize that wage incentives are an essential tool of industry, for two desirable purposes: (*a*) Increasing total production and (*b*) automatically gaining for workers their fair share in the increase.

HEATED THINKING

The difficulty is that labor, in its thoughtful long-range thinking, is often different from labor in the heat of organizing and bargaining. We have that experience with management,

[1] The state referred to is Wisconsin. At the last session of the Legislature, a bill was introduced into the Assembly to prohibit employment under a group system, standard time system, or any other wage-incentive plan usually referred to as "point-premium plans." The bill received no encouragement from the administration and little other support. Shortly after it was introduced, it was laid upon the table and was not taken up until a few days before adjournement, too late for any action to be taken on it. For those who may be interested in this proposed legislation, the number of the bill is 647-A.

During the last session of the Assembly, a substitute amendment, No. 1-A, was introduced which will not bar incentive systems but will insist upon certain efforts in connection with them. A quotation from the amendment is as follows: "Every employer operating under an incentive system of wage payments shall be required to maintain and have available to each individual employee, within his department, full information as to the basis and method of payment of his wages, incentive earnings, and bonuses. Every employer operating under an incentive system of wage payments shall be required to have available to each individual employee daily, within his department, full information as to the amount of his incentive earnings for the preceding workday except . . ." (A list of exceptions follows.)

Although competent observers believe that the original legislation will not be enacted, a feeling exists in Wisconsin that legislation somewhat along the line of the amendment will be adopted.

Contributed by the Management Division and presented at the Fall Meeting, Erie, Pa., Oct. 4–6, 1937, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

also. Hence, the practical problem which thoughtful management faces in meeting the present opposition to incentives—an opposition that is directed not so much against incentives per se as against any element which interferes with an evening out and dead leveling of labor for bargaining purposes.

Wage incentives create differentials of production and pay, an infinite number of them. They create a stake in the exercise of individual initiative. Both differentials and individual loyalties seem to complicate the organized labor picture.

Before the days of widespread collective agreements and before the organized mass labor pressure movement, this trend of opposition was not particularly important. Its importance with you today rests upon your opinion as to how large an area you believe organized labor is to cover, eventually.

SIMPLIFICATION

But industry has not been idle, while this trend of opposition has been gaining momentum. Far-seeking industrials have realized that the final decision as to incentives is to rest with the worker himself. For some years, the trend toward simplification of incentive systems has been growing. A recent survey indicates that 32 per cent of the firms questioned believe that their present incentive systems should be simplified; a frank admission.

In the enthusiasm that developed as an outgrowth of scientific management, we saw a multitude of scientific wage-payment formulas develop which were sound in general principle and laudable in broad objectives. Often, these formulas were just too complicated in operation for the average worker to understand. This second trend, simplification, means, essentially that industry is awakening to the fact that no incentive system can be truly effective unless under it the average worker knows at the end of the day, just what he has made, and why he has made it. This trend would seem to be the really sound answer to the problems created by trend No. 1.

I do not believe that management will lie down on the incentive question because of the tactical opposition of organized labor. Rather, management will fight out the battle with organized labor's bosses, the workers, endeavoring to develop a full enthusiasm for, and confidence in, incentives on the part of the workers of our country. Far-seeing management sees that, if workers are really satisfied, no organized labor opposition will be encountered. In this development, the trend toward simplification has a major function.

PARTNERSHIP DEVELOPMENT

A complimentary trend, No. 3, is partnership development of plans and procedures. By that phrase, I mean the tendency of management to take organization into its confidence, in the formulation of policies and procedures. Striking in this connection is the experience of a well-known Wisconsin firm. This company spent, literally, months of time with its supervisor-and-worker representatives in what might seem to many, a fruitless detail discussion, before the final mold of wage-payment plan was cast. The patience required for this way of developing a procedure is astounding, but the rewards are permanent and sizable.

If we would have workers content with, and backing up, our wage-payment plans, and the changes that we make in them from time to time, we must realize that we have a selling job to do, a job of making workers "want to buy and stay bought," because they have had a part in formulating the conditions under which they work. If we would avoid labor resistance to incentives, we must realize that we must eliminate all fear of, and suspicion of, management and the misunderstanding of its intentions, which is natural on the part of all workers. It is upon this that the self-seeking type of labor leader feeds.

INCREASED USE

For trend No. 4, let us record the growing use of incentives. In evaluating this trend, it is not safe to rest upon impression, strong as that may be. Hence, I refer again to the survey of industrial practice. This revealed the fact that 52.8 per cent of the companies approached were increasing the use of incentives, whereas only 3.8 per cent were decreasing such use.

What is back of this fourth trend? Two fundamentals, I believe. First, the fundamental concept that the basic welfare of America and its people rests upon increased production of new wealth, rather than upon division of present wealth. The wage incentive is recognized as one of the most potent and dependable stimulants to increased production of wealth. A second fundamental concept is that the industrial picture is more sound if the growing pressure for greater return to labor can be directed into a definite relationship of wage return and production, instead of remaining as a force for the arbitrary and continued boostings of wage levels.

WAGE TRENDS

Let us look at the current wage trend. Here are significant figures from the statistical surveys of the National Industrial Conference Board, which has built up a sufficient contact with industry as a whole to render its findings indicative. Figures of the Board show that from 1933 to July 1, 1937, average hourly earnings increased 31.8 per cent. This is a splendid gain and a tribute to the efforts of those who have sought to improve the lot of the worker.

But the difficulty is that in the same period during which this increase of 31.8 per cent was accomplished, average production per man-hour increased only 4.9 per cent. Here is a tendency to spread which, if left unchecked, bodes dire consequences. We do not get far by taking money from one pocket and putting it in another.

MEASURED DAYWORK

In an effort to solve the current problems, the tendency seems to be to turn to measured daywork or some practical equivalent. As ordinarily used, measured daywork fixes hourly wage rates by setting uniform base rates by occupation and then gives added inducements, which are determined separately for each employee on the basis of four factors, (*a*) employee's performance or productivity, (*b*) quality of his work, (*c*) his dependability, and (*d*) his versatility.

One of the advantages which is claimed for measured daywork is that the employee's performance is judged over a relatively long period, not less than a month and preferably three months, thus making sure that the hourly wage is constant for a reasonable period, and eliminating uncertainty. Measured daywork is advocated as a solution to the problem of stimulating the employee to all effort that is desirable from the standpoint of company profit; yet, at the same time, claim is made that it is readily understandable by the average employee and he has certainty of fixed earnings for a reasonable period.

This growing appreciation of measured daywork may be noted as a fifth trend. The survey shows that 7.8 per cent of firms who were contacted were using measured daywork, while 10.1 per cent are considering it.

ACCURACY OF STANDARDS

Advocates of measured daywork insist that it puts an emphasis on a factor which has come to be recognized as all important; namely, the establishment of scientifically accurate

standards of performance. And, after all, this consideration is even more important than the particular type of payment method used.

It has been difficult, and usually is costly, to set accurate standards for the multitude of operations involved in a manufacturing process; but, unless accuracy of standards is made a definite objective, unrest, misunderstanding, dissatisfaction, and difficulty are bound to arise. I will go so far as to indicate that a sixth trend is toward the establishment of sound standards, no matter what the type of wage payment.

I have no measure in this respect, because this is a delicate matter in which intentions are often wrongly impugned. But the upgrading of the type of men who are being utilized for standards work, the growing interchange of technique between industries, and the improvement in methods of work study are significant signs.

A HOPE

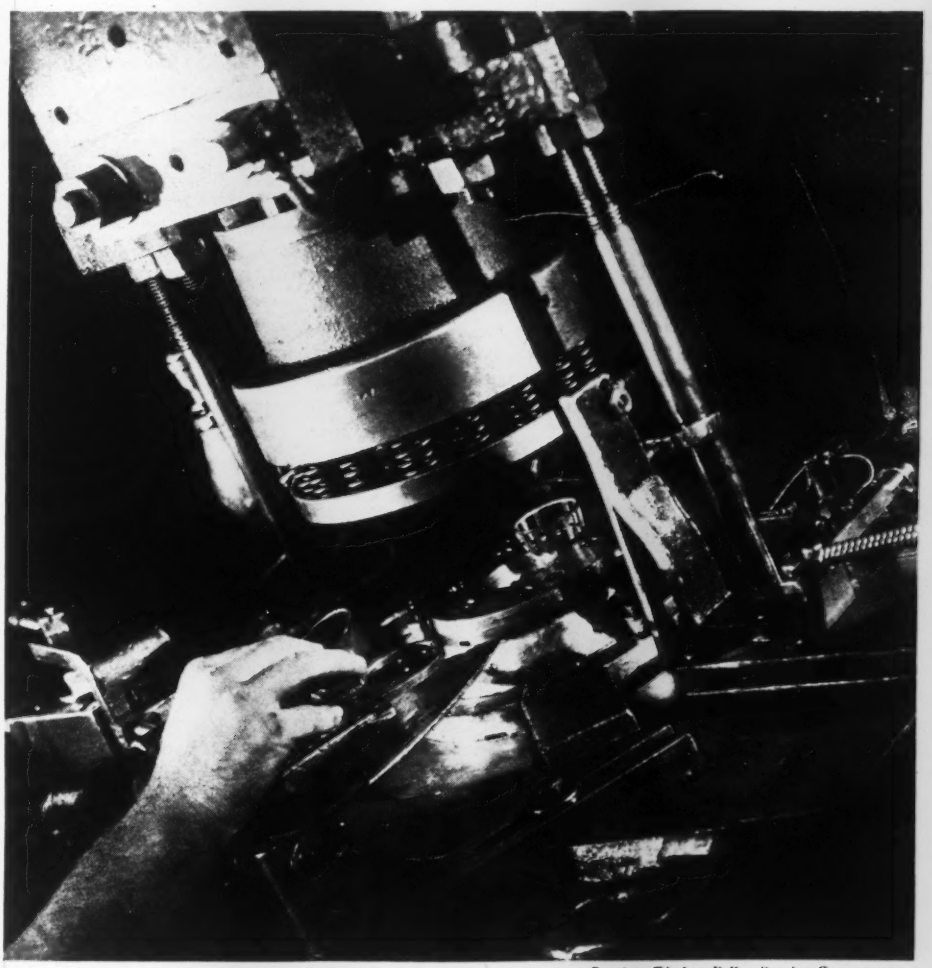
I wish that I might claim a trend in incentives that would become a veritable mainspring of human effort, the month-by-month and year-by-year security of the pay envelope. But the situation here, I conceive to be mainly one of wishful, watchful waiting with regard to such isolated experiments as those of Nunn-Bush, Hormel, and a few others.

I believe that large areas of industry are willing today to do the right thing in this direction. Perhaps, we await the return of full confidence in the stability of the economic order for a definite trend in the direction of the guaranteed take-home. Hence, the hope that conditions will soon make the move seem a practical one. I believe that many managers have the sense to recognize the significance of the guaranteed hourly wage and the courage to pioneer in that direction. For it can be made the outstanding incentive to worker confidence, worker security, and worker effort.

MANAGEMENT MUST EXPLAIN AND SIMPLIFY

May I close this brief review of trends in incentives with a reference to what I believe to be fundamental in the entire picture of the wage question? Despite every opposition, this is the establishment, as a principle of American thinking, that neither worker nor industry gains by worker opposition, but that both gain by worker cooperation with all movements that increase production.

Management has a major responsibility in this connection, especially its representatives who have to do with administration or development of wage payment and production methods. Management must simplify! Management must explain! But above all, management must be eternally sold on, and salesmen of, the fact that our economic salvation is inseparably tied-in with an organization relationship which will insure wholehearted cooperation for increased production.



Courtesy Timken Roller Bearing Company

PERFORATING A PRESSED-STEEL BEARING CAGE TO RECEIVE THE TAPERED ROLLERS

PROSPERITY *and* DEPRESSION

By EARL F. BEACH

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THE CONTROL of the business cycle is one of the most puzzling problems existing today. Much has been written about fluctuations in business activity, and in recent years, some attempts have been made to control them; but as yet the writings have not been very definitive, nor the attempts particularly successful. Meanwhile the damage being done by these fluctuations threatens to become greater in the future, rather than less. Can the difficulties be met by any system of organized control short of socialism? Can socialism itself prevent the evil? In either case, would the costs, which would be in the form of restricted freedom and slower technical progress, be justified?

These questions have not yet been answered satisfactorily, but we are in a better position to answer them than we were a few years ago. Professor Haberler's recent book is a big step in this direction. It is the best work on business cycles that has yet appeared in English. Although he has little or nothing to say on public policy, he does an excellent job of analyzing cyclical movements in business. "Prosperity and Depression" is part of a much larger study of business cycles being undertaken by the League of Nations. Professor Haberler's part in that is to collect important theoretical explanations of business fluctuations and make a synthesis. This he does very well.

The book is divided into two parts, the first of which is devoted to a digest of existing explanations of the business cycle. In order to cover this broad field in 157 pages, the author refers to types of theories instead of to individual theories, a method which also brings out the similarities and differences between the individual contributions. Some theorists may feel that their explanations are inadequately considered, but certainly this part of the book is an excellent survey of those theoretical explanations of the business cycle which have any acceptance among economists today. The ideas of Major Douglas, or of the Technocrats, are not mentioned. Those explanations which are discussed are classed under the headings of purely monetary theory, over-investment theories, cost and maladjustment theories, under-consumption theories, psychological theories, and agricultural theories.

The second part of the book contains the synthetic exposition, a most readable exposition, since the author does not use technical language. In fact, he often helps to clarify some of the technical expressions which other economists deem it necessary to use. While most theorists, in constructing a theory of the business cycle, pick out one or two features of the cycle and emphasize them as fundamental, showing how they work into the other characteristics of the cycle, Haberler attacks the problem differently. He defines the cycle and shows how it can be measured in terms of fluctuations in employment, income produced, and income consumed. The movements in these three series he considers to be the most important aspects of the cycle. The difference between income produced and income consumed is, of course, the quantity of capital goods which are not available for consumption.

The author then proceeds to treat each of the four phases of the cycle, starting with the processes of expansion and contraction. An important part in these processes is played by what he calls the market for "investible funds." It would have been helpful if this market had been described in more detail, especially the condition existing toward the end of an expansion phase. The description of the turning-point phases, the downturn or recession, and the upturn or revival, is very interesting. Proximate causes of an upturn or a downturn are very numerous, and some are almost always present, but they have different effects at different times. Indeed, the same incident may bring about a revival or a recession, depending upon the underlying conditions. In the beginning of an expansion phase, the tendencies are not strong, and almost any incident of any importance may check the movement. But if the movement continues, it gathers strength so that a much more important incident is required to check the growing tendencies. Finally, after this expansion movement has continued for some time, the system becomes less capable again of withstanding deflationary shocks. Eventually, therefore, there will come some incident which will start the next phase of the cycle. The contraction phase takes place in a similar fashion, which suggests that if the contraction is caught soon enough, public works may help to prevent or postpone a deflation. This general treatment is new and aids in understanding cyclical movements in business.

The final chapter of the book deals with the international aspects of the cycle. Here the author, who is an authority on international trade, shows the importance of transportation costs and tariffs, and the lack of close business conditions in general, in allowing business conditions to be greatly different in various parts of the world at the same time. Business cycles may actually be in opposite phases in two different countries. An interesting section in this chapter describes the spreading of the cyclical influences. Effects of imposing new tariffs and of fluctuating exchanges are also considered.

There is one aspect of the business cycle that has been relatively neglected in the book. Haberler might have said a little more about the length and the severity of the expansion and contraction processes. He mentions that one of the intensifying factors of the contraction process is the postponing of the reinvestment of amortization quotas, but he underestimates the significance of this. Similarly, although he shows how important it is when people fail to spend money which they have or can get, he does not examine fully the position of the business man in particular, who postpones certain business expenditures. It seems obvious that once a contraction has begun, business men will be faced with an uncertain future, and they will not spend any more than is necessary. All expenditures that can be postponed, will be postponed, and the expenditures on durable capital are perhaps most easily controlled by the managers. The extent to which such expenditures can be postponed will vary a good deal from one recession period to another, depending upon how much durable capital was installed during the previous expansion phase. Therefore, it may be said that a period of contraction is much more likely to be seriously prolonged if there has been much building of durable capital during the previous years; and the difficulties are not likely to be so great if no chance for such building up occurred, as in the case of the recession that followed soon after the close of the Great War.

"Prosperity and Depression," by Gottfried von Haberler, League of Nations, Geneva, 1937.

One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Day by Day

EVENTS go forward with such a rapid pace that many that warrant record and comment because of their interest to engineers have to be omitted.

Because of discussions taking place in Washington relating to Naval appropriations, attention is focused on the recent successfully completed flight of the "flying fortresses" to South America. Much is also heard of the cost of ship construction in this country as compared with abroad, and with the labor conditions in the merchant marine.

Tribute might well be paid to the engineers of the famous arch bridge at Niagara, victim of unusual ice conditions, that was a seven-day wonder forty years ago because of the dramatic setting and the fact that it was then the longest of its type to have been constructed. Built by the Pencoyd Iron Works, its main span was a two-hinged arch rib about 20 ft deep and 840 ft from center to center of pins. Richard Kuhen, Jr., of Pittsburgh, Pa., who was Pencoyd's job engineer for the bridge, writes, in response to a query, that "the arch was erected by the so-called cantilever method, bracketing out from each end and using eyebar chains anchored in the rock to take the tension. By using a temporary pin in the bottom chord at the middle, the arch was swung as a three-hinged arch, afterward changed to a two-hinged arch by jacking the calculated stress into the top chord. This was new to me," he continues, "and was the idea of Paul L. Woelful, assistant chief engineer, Pencoyd (now deceased). It has been used frequently since. The figured length for the top chord section at the calculated stress was an exact fit, which was, of course, very gratifying."

Mr. Kuhen has also provided the names of some of the engineers of the project. C. C. Schneider, deceased, past-president, American Society of Civil Engineers, was chief engineer for Pencoyd. L. L. Buck, deceased, was chief engineer for the owner. R. S. Buck, at present living in Washington, was resident engineer for L. L. Buck.

And speaking of bridge designers, mention should be made of the death, on March 3, of J. R. L. Waddell, well-known for the many lift bridges built from his designs. Eighty-four at the time of his death, he is remembered for his interest in young engineers and for his addresses and writings in their behalf.

Nor can any engineer be unimpressed by the life of Harvey A. Firestone, recently deceased, a rugged industrialist of America's golden era. His lifework lay in a manufacture that depended on a raw material not indigenous to America but without which the automobile would have been so seriously handicapped that it might never have been developed at all. His efforts to provide for this country a source of raw rubber not subject to foreign control called for vision and courage.

One of the most picturesque and famous of former A.S.M.E. members returned to public consciousness when Commander Ellsberg's epic of arctic adventure, "Hell on Ice," made its appearance in the bookshops. The story of the ill-fated expedition of the *Jeannette*, which attempted to drift with the ice pack north of Bering Strait to the North Pole where it was caught in the ice, crushed, and sunk, is told by the author who impersonates Admiral George W. Melville, chief engineer of the *Jeannette*, who brought a portion of the adventurers safely home. Commander Ellsberg says that he chose Melville for the rôle of spokesman in the book because the admiral was an engineer, and Ellsberg therefore had a feeling of kinship with him. Dean Mortimer E. Cooley, in a recent letter about Melville, tells of a telegram sent to one of Cooley's shipmates by Melville just before the *Jeannette* sailed. The telegram read, significantly, "Hurrah for Hell—Melville."

Melville became engineer in chief of the United States Navy during the period when the so-called "new Navy" was being built. He served as president of the A.S.M.E. in 1898. He created in his will a trust fund to be held by the Society, the income to be devoted to a gold medal to be awarded for the best paper on any mechanical subject. In the Society rooms a bronze bust of Melville portrays the strong, bearded face and flowing locks of the courageous and adventurous engineer.

Miners

Bringing to a close the winter conventions of the Founder Societies, the American Institute of Mining and Metallurgical Engineers, with a total membership of 11,331, registered 2400 at its 148th meeting in the Engineering Societies Building, New York, February 14 to 18. To judge from scenes in the flower-decked lobby of the building, thronged with friendly groups and filled with a noisy hubbub of eager conversation, miners have a highly developed sense of gregariousness and sociability. It seemed like a good old homecoming with everybody having a grand time playing the more respectable part of the rôle of the prodigal son. Perhaps the best evidence of the engaging human qualities of mining engineers was the fact that a large number of the wives were present and seemed to be enjoying the general confusion as much as the menfolk did.

Some idea of the extent of the technical program can be had by noting that it contained the names of about 270 authors, 170 papers, not to mention addresses and symposia, as many as eight simultaneous sessions in a single morning, and 20 committee meetings. Just to be sure that no one would feel bored when technical sessions were adjourned there were special and general luncheons every day, special dinners on Tuesday and Thursday, a general dinner-smoker at the Waldorf-Astoria on Monday evening, preceded by "alumni" meetings, an informal dance on Tuesday evening, an annual dinner and reception Wednesday evening, an All-Institute session at which H. G. Moulton and Leo Wolman spoke, on Monday afternoon, an annual business meeting, a gathering of section delegates, a special feature for student associates which included a demonstration of employment interviews, and a lecture by P. W.

Bridgman, of Harvard. At the end of this busy week a party of 31, including Secretary and Mrs. Parsons, sailed for Bermuda.

The annual dinner of the Institute, attended this year by 800, provided the occasion for the bestowal of medals and awards, an agreeable substitute for after-dinner speeches. With Rolland Crater Allen, president of the Institute as toastmaster, a certificate of honorary membership was presented to John V. W. Reynders, professional adviser to steel works and banking institutions, and president of the Institute in 1925. Insignia of the "Legion of Honor" were presented to ten "members of the class of 1888" (on the Institute's rolls for fifty years), of whom D. S. Jacobus, honorary member and past-president, A.S.M.E., was one. The Robert W. Hunt award of $250 for the best Institute paper published during the year on iron and steel was presented to Thomas S. Washburn and John Hunter Nead. Roy Alexander Lindgren received the J. E. Johnson, Jr. award for men not over forty who have shown exceptional promise in research, invention, or contributions to the literature of iron and steel. To Hal Williams Hardinge, known throughout the world for the 3000 Hardinge conical type of ball mill, was awarded the James Douglas medal for distinguished achievement in nonferrous metallurgy. Another international figure, Henry L. Doherty, president, Cities Service Co., member, A.S.M.E., was awarded the Anthony F. Lucas medal for distinguished achievement in improving the technique and practice of finding or producing petroleum. Following the presentations, Daniel Cowan Jackling, president of the Institute for 1938, was introduced.

Elsewhere in this section will be found an account of the Student Associate Session which Howard Lee Davis, of the New York Telephone Company, addressed on the subject, "Preparation for an Employment Interview," and of the demonstration of interviews of students with prospective employers (page 355). A digest of some papers on powder metallurgy will be found on page 333.

The temptation is great to quote extensively from the paper "Technology, Economics, Government, and Progress," by Harold G. Moulton, president of the Brookings Institution, from that on labor and capital, by Leo Wolman, of Columbia University, and from the lecture by P. W. Bridgman, of Harvard, entitled "New Metals Produced by High Pressures," but a few quotations must suffice.

Dr. Moulton's paper was reminiscent of others, already reported in this section in February and March, respectively, presented by him at the Indianapolis meeting of the A.A.A.S. and the Winter Convention of the A.I.E.E. At one point he said:

The solution of the problem of technological unemployment must be found in business policies which will insure an expansion of purchasing power among the masses of the people in proportion to the increase in productive capacity. If increased efficiency in production is not followed by expansion of mass purchasing power, and hence by an increased demand for employment in the production of additional goods and services, then unemployment will inevitably result. If, on the other hand, the buying power of the masses is increased in direct proportion to the increase in productive efficiency, demands for new products and for more employment will automatically ensue. The maintenance of a balanced and progressive economy depends upon the rapid dissemination of the benefits of technological progress.

From Dr. Wolman's paper the following passage has been taken:

The conditions of labor we have latterly put into effect in this country seem to depart from accepted standards of moderation and reasonableness. They are gaged to the conditions of business at the peak of booms and as such may successfully prevent improvement in business when industry is on the rise or may fail to arrest the fall when industry is in a decline. It is true that these conditions do not bear with equal weight on all enterprises, but the area of their influence is sufficiently wide to make them of crucial importance.

These labor policies, finally, do not stand by themselves; nor are they new or peculiar to this country. They are integral elements of the larger policy of price control, restriction of output, pump priming, and the raising of consumers' purchasing power. As such they have run a long course in many parts of the world and they have not come through with flying colors.

An Austrian economist writing of the application of similar policies in his native country takes this gloomy view of their consequences. "Austria," he says, "was successful in pushing through policies which are popular all over the world. Austria has most impressive records in five lines: she increased public expenditures, she increased wages, she increased social benefits, she increased bank credits, she increased consumption. After all these achievements she was on the verge of ruin."

As for Professor Bridgman's lecture, the following excerpt will explain its general nature.

Within the last few years the wave-mechanics theory of solids has progressed so rapidly that it is possible in many cases to calculate and even anticipate what the effect of pressure should be on a number of simple properties, and this possibility has for me greatly increased the interest of the experimental work. At the same time, my experimental work has entered on a new phase, improvements in technique making it possible to reach pressures of 50,000 kg per sq cm, several fold higher than the previous range, and to measure a few simple properties in this range. In this extended range there are very notable departures from linearity with pressure, so that the task of the theory is to reproduce whole curves instead of the straight lines that would have sufficed to reproduce experimental knowledge over a shorter pressure range. Theory is now proving adequate for this task in the simplest cases. I shall try in the first place to give a summary of the new experimental knowledge with regard to metals which I have been able to gather in the extended pressure range, and in the second place to show how these data are fitting into the theoretical picture painted by wave mechanics. We must not make too great demands on the theory, which is still in the early stages of its development, but even so, I think that our theoretical understanding is immeasurably better than we would have dared to hope fifteen years ago.

Smeatonians

From the Newcomen Society for the Study of the History of Engineering and Technology comes a copy of a paper by Esther Clark Wright entitled, "The Early Smeatonians," presented at the Chartered Institute of Patent Agents, Feb. 16, 1938. The Smeatonian Society of Civil Engineers, which held its inaugural meeting in Holborn, March 15, 1771, was a short-lived engineering society, earliest of such associations formed in England, or any other place outside of France. John Smeaton, for whom the society was named, is said to be the first man to call himself "civil engineer," and is remembered as designer and builder of the Eddystone lighthouse. An English translation of the Society's somewhat defiant Greek motto reads: "We conquer by art the difficulties offered by nature."

The paper referred to contains some notes on the engineers present at the inaugural meeting, who were, in addition to John Smeaton, Thomas Yeoman, the society's first president,

John Grundy, Joseph Nickalls, J. King, John Thompson, and Robert Mylne. These early Smeatonians engaged mostly in surveys, canals, and river improvement works. The concluding paragraph of the paper states that there was in Great Britain during the eighteenth century a much more firmly established and self-conscious profession of civil engineering than has been supposed. The men who were practicing this profession did not begin to call themselves civil engineers until near the end of the century, but they did call themselves engineers. Also, they were indigenous, and they grew up entirely apart from military engineering practice. To the Thames, the Dee, the Clyde, and those sluggish rivers of the inland they owe their being.

Centenary

Shortly after the beginning of the year the *Leviathan*, of the United States Lines, originally christened the *Vaterland* and in later years affectionately called the "Levi Nathan," sailed from New York on her final voyage, to be broken up in Great Britain. For years the weather-beaten ship was a familiar sight on the Jersey shore of the North River where she lay, all but forgotten, a victim of obsolescence or, perhaps, of "technological unemployment." Too costly and too large for economical operation in an age of the *Queen Mary* and *Normandie*, an age of national pride and subsidy, what value remained in the *Leviathan* was in the form of scrap metal. Hence, instead of peacefully "rotting to flowers and fruit like Adam and all mankind," she is doomed to reappear, unrecognized, perhaps as part of other ships, perhaps as munitions, and plagued, like the old and weary Frankish king haunted by Roncevaux, with visions of new wars.

In the continually changing phases of progress and obsolescence, throughout which fortunes ebb and flow, and the new becomes old, objects of man's inventive genius must face the common alternatives of adaptation or extinction. For years after the *Sirius* and the *Great Western* made the first westward crossing and inaugurated the steam era on the Atlantic, clipper ships held the popular imagination and were employed in the longer runs. It was on April 4, 1838, that the 703-ton channel steamer *Sirius* left Cork harbor to arrive, on April 22, at New York, followed on the next day by the arrival of the *Great Western*, first steamship to be constructed for the Atlantic crossing. After a lapse of 100 years there are promises of regular airplane service over the same routes, and, as noted in the January issue (page 62), according to the report of the United States Maritime Commission, "future developments in the realm of fast service appear to be in the air, rather than in the building of extravagant superliners."

The *Great Western*, designed by Brunel, made enough crossings to convince men of the seriousness of the competition offered sailing craft by steamships. She was built at Bristol by Patterson, and her engines were made at Lambeth by Maudslay, Sons, and Field. The centenary of her epoch-making voyage will be celebrated in this country and in Great Britain by the Newcomen Society.

One month before the *Great Western* arrived at New York, Colonel John Stevens, of Hoboken, who, in 1804, made the first practical screw-propelled steamboat, died on March 6, 1938. The bitter controversy between Stevens and Fulton had at least a meager compensation for Stevens. Because of a monopoly granted to Fulton of navigation rights on the Hudson River, Stevens sent his *Phoenix* to Philadelphia, which thus achieved the distinction of being the first steamship to make a voyage on ocean waters.

Airships

And speaking of centenaries and Atlantic crossings, Count Zeppelin, of rigid-airship fame, was born on July 8, 1838. The splendid record of the Zeppelin airship, marred by the recent disaster of the *Hindenberg* by the explosion of hydrogen lifting gas, is soon to be resumed by the new helium-filled dirigible being outfitted in Germany.

In the March, 1936, issue of MECHANICAL ENGINEERING (page 142) attention was directed to a report of the Science Advisory Committee, which recommended that the U. S. Navy department continue with a positive carefully considered program of airship construction. A special committee on airships, made up of distinguished scientists and engineers with William F. Durand, honorary member and past-president, A.S.M.E., as its chairman, was set up "to review and analyze the past and present situation of airships (dirigibles) and to make recommendations as to their future design and construction." Three of this committee's reports have been made public, the first of which was referred to in the reference of a year ago, just mentioned. On March 1 of this year the House Naval Affairs Committee allocated $3,000,000 for a dirigible of 3,000,000 cu ft capacity for "training, experimental, and development purposes," a restriction in line with the special committee's recommendation that the first large airship be considered "not an adjunct to the fleet but rather a flying laboratory or flying training ship."

Doherty

General approval will greet the announcement that Robert E. Doherty, president, Carnegie Institute of Technology, has been awarded the 1937 Lamme medal of the American Institute of Electrical Engineers "for his extension of the theory of alternating-current machinery, his skill in introducing that theory into practice, and his encouragement of young men to aspire to excellence in this field." The medal will be presented at the annual summer convention of the Institute, Washington, D. C., in June.

Mr. Doherty is one of those versatile engineers who find success in more than a single field. Coming early under the influence of Steinmetz at the General Electric Company, he later became eminent in his own right in work of the type that made Steinmetz famous and carried on this work after the great man's death. The peculiar needs of the designer in the electrical industry, and the inadequacy and immaturity of training possessed by young engineers coming from college to the Schenectady works, forced Doherty into educational work when he was selected to organize the advanced course in engineering offered by that company. Enriched by this experience, he accepted, in 1931, the call to become head of the department of electrical engineering at Yale, a position made vacant by the retirement of Charles F. Scott, former associate of Lamme at Westinghouse. In 1933 Doherty became the first dean of the Yale School of Engineering, and three years later received the appointment of president of the Carnegie Institute of Technology.

Doherty's educational philosophy and method derive in part from his industrial experience and in part from the quality of his own mind with its capacity of viewing all problems in broad perspective. At Yale he boldly attacked the teaching problem and instituted innovations in method with the conviction that engineers must not only be competent to use the special mental tools of their profession with facility and imagination, but also comprehend the relationship of engineering to other cultures and view broadly the significance of this

relationship. As announced in this section in February (page 155) the gift of $300,000 from the Falk Foundation to Carnegie Tech will assist Mr. Doherty to put his educational theories into practice at that institution.

Matschoss

Announcement has been received of the retirement, after 32 years of active service, of Conrad Matschoss, life member and Fiftieth Anniversary medalist, A.S.M.E., as director of the Verein deutscher Ingenieure. On Jan. 1, 1938, Dr. Hans Kölzow, of Berlin, active on the Board of the V.D.I. since Oct. 1, 1937, became director.

Through several trips made to this country Dr. Matschoss added to the number of his friends and admirers among engineers, a number already large because of courtesies extended by him to Americans visiting Germany. The warmth and friendliness of his personality instantly attract those who meet him for the first time and remain as pleasant memories of enduring satisfaction. Long years of service in an institution where a sympathetic understanding of human nature is an essential asset have ripened these qualities. Furthermore, studies of the history of engineering and technology, a field in which Dr. Matschoss, as a pioneer, has retained a leading position, have broadened and deepened his interests, his understanding, and his sympathies. As editorial leader he has placed the publications of the V.D.I. in the first rank in Germany and in the world, and has established a model of quality and comprehensiveness that others would be proud to imitate.

Filled with a historian's zeal, Dr. Matschoss has called the attention of his countrymen and others to the contributions of the German people to the development of technology and engineering. He has assisted in the preparation and preservation of historical landmarks and records in this field, and thus, acting as a link between the past and a rapidly advancing future, has shown how this sector of human culture is related to others in the vast complex of cultural achievement.

As Calvin W. Rice did in this country, Dr. Matschoss in Germany added to the dignity and influence of engineering societies and the engineering profession, and to the understanding of engineers in each country of the international aspects of their work and interests. If any satisfaction is to be gained from his retirement from the V.D.I. directorship, it will be in the hope that, relieved of administrative duties, he will find more time and energy to continue his contributions to the history of engineering, and more leisure in which to enjoy the fruits of a rich and active life.

Railroads

On February 16, 1938, supported by convincing statistics, L. K. Sillcox, member, A.S.M.E., made a telling attack on Senate Bill S.69 introduced into the 75th Congress by Senator McCarran, of Nevada, that proposes a limitation of the size of freight trains to no more than 70 cars. Mr. Sillcox's attack was in the form of an address entitled, "The Economics of Freight Train Handling in Mass Transport," delivered at the Graduate School of Business Administration, Harvard University.

Supported by railway labor organizations as a safety measure with the claim that compliance with its terms need not involve the railways in any considerable added operating expense, the bill is shown by Mr. Sillcox' statistics to be likely to increase, rather than decrease, accidents, while railway estimates claim the additional expense entailed, were the bill to be enacted, to be in excess of 100 million dollars per year.

Mr. Sillcox analyzes 1936 train-accident-fatality statistics into classes that are (1) affected by the number of trains operated (2) independent of the number, (3) attributable to internal train shock, and (4) caused by misinterpretation of signals. The distribution of the accidents is recorded in the accompanying table, taken from the paper.

Accident type	Accident class	Trespassers	Nontrespassers	Employees
Affected by number of trains operated	1	1273	696	138
The "independent" group.	2	620	4	80
Accidents attributable.. to internal train shock	3	20	0	12
Misinterpretation of signals	4	0	0	0

Public attention, said Mr. Sillcox, is being focused by railway labor on the third and fourth class of accident, which are said to be more prevalent with the long train. However, existing designs of draft-gear and power-brake equipment, together with the required maintenance of both, assist in the prevention of accidents of this type. No fatal accidents of the fourth type are reported.

Commenting on these statistics, Mr. Sillcox said: Can the specter of fear of fatal accident involving one man be advanced as a reasonable motive for equally endangering the lives of 66 others? Or, to restrict our comparison to consideration of the railway employees who would invite this condition, can the fear of death of one man justify exposing 12 others, similarly employed, to the same fate? Moreover it is to be noted that trains in excess of 70 cars in length were not responsible for all, nor for the majority, of the fatal accidents resulting in shock arising from train handling. In fact, but six of the 32 trains involved in fatal shock accidents, consisted of more than 70 cars.

Accidents which occur to trespassers, a class consisting, for the most part, of tramps and hoboes, should have little influence upon measures for improving railway safety. Recourse can only be had to discipline in controlling these men and it is a matter of social interest wherein the state might quite properly cooperate. Considering the two classifications of individuals, nontrespassers and employees, the table shows fatal injuries to 700 nontrespassers and 230 employees. Practically all nontrespassers (all but four) met their death by reason of conditions which any increase in the number of trains would aggravate. An increase of 60,000,000 train miles operated in 1936 to handle the same traffic, had no trains consisting of more than 70 cars been permitted, would have resulted in an increase of 38 fatalities of occupants of passenger automobiles at railway grade crossings, based upon analysis of 1936 figures. How futile it would be to invite such a condition, in order that the long train might be eliminated. Six men, two of them railway trainmen, lost their lives on long trains due to shock accidents in 1936 and many more were killed due to similar causes when employed in the handling of short trains. It is true that any condition resulting in the death of six men is a matter of concern. Such occurrences must be prevented if it is in any way possible. Surely the solution does not reside in endangering the lives of many times six others.

Summarizing his comments on the train-length bill Mr. Sillcox said:

A bill which would limit the length of freight trains threatens the safety of the individual—not the trainman alone but all who must cross railway properties at grade or ride in

trains. This should be self-evident from the sheer mathematics of the proposition. It would interfere with the standards of service already attained and disrupt the plan of continued improvement now in effect. It would destroy property values while affording no compensation. Impartially viewed, it is impossible to discover a single element of merit to support it.

The attitude of railway labor toward management is the most disheartening influence with which the administrations have to contend, said Mr. Sillcox. So much could be accomplished for their mutual benefit if labor were willing to align its fortunes with the interests of those who own the properties, sacrificing during difficult periods and sharing alike in the rewards of a prosperity to which it had contributed. The corrosive attack upon dwindling profits and feasting upon the spoils of an organized invasion will be met with its own misfortune. Men, methods, and machines are still imperfect and these very imperfections give employment to many. If labor chooses to pursue the course of coercion it has laid down, and if the public is disposed to support labor in its economically unjustifiable demands, both must be prepared to accept the inevitable repercussions which such a program must excite.

Air-Cooled Engine Cylinders

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

HEAT-transfer processes in air-cooled engine cylinders are analyzed in report No. 612, written by Benjamin Pinkel for the National Advisory Committee for Aeronautics.

From a consideration of heat-transfer theory, semiempirical expressions are set up for the transfer of heat from the combustion gases to the cylinder of an air-cooled engine and from the cylinder to the cooling air. Simple equations for the average head and barrel temperatures as functions of the important engine and cooling variables are then obtained by the author from these expressions. The expressions involve a few empirical constants, numerical values for which were obtained from single-cylinder engine tests for cylinders of the Pratt and Whitney 1535 and 1340-H engines.

In the tests each cylinder was mounted on a single-cylinder test stand enclosed in a jacket through which cooling air was forced by a centrifugal blower. The jacket had a wide entrance section to provide a low air velocity over the front half of the cylinder, and over the rear half the jacket fitted closely against the fins to provide high air velocity, as shown in Fig. 1.

The 1535 cylinder was provided with two devices for disturbing the air flow over the front of the cylinder to determine the additional cooling due to the disturbed motion of the air in front of the cylinders of a cowled engine in flight. One of the devices was a cylinder 9 in. in diameter mounted about 4 in. ahead of the fin tips with its axis at right angles to the cylinder axis, as shown in Fig. 1(*b*). The other device consisted of baffles for directing the cooling air downward over the front of the head and barrel, as shown in Fig. 1(*c*) and (*d*). The lower baffle, a semicircular sheet placed about $1^1/_2$ in. from the fin tips, provided a fairly high vertical velocity of the air.

A partition was located in the exit duct for separating the air that flowed over the head from the air that flowed over the barrel. Thermocouples were located in the jacket ahead of the cylinder as well as in the exit passages from the head and barrel for measuring the increase in temperature of the cooling air.

A static tube was located in the space ahead of the cylinder,

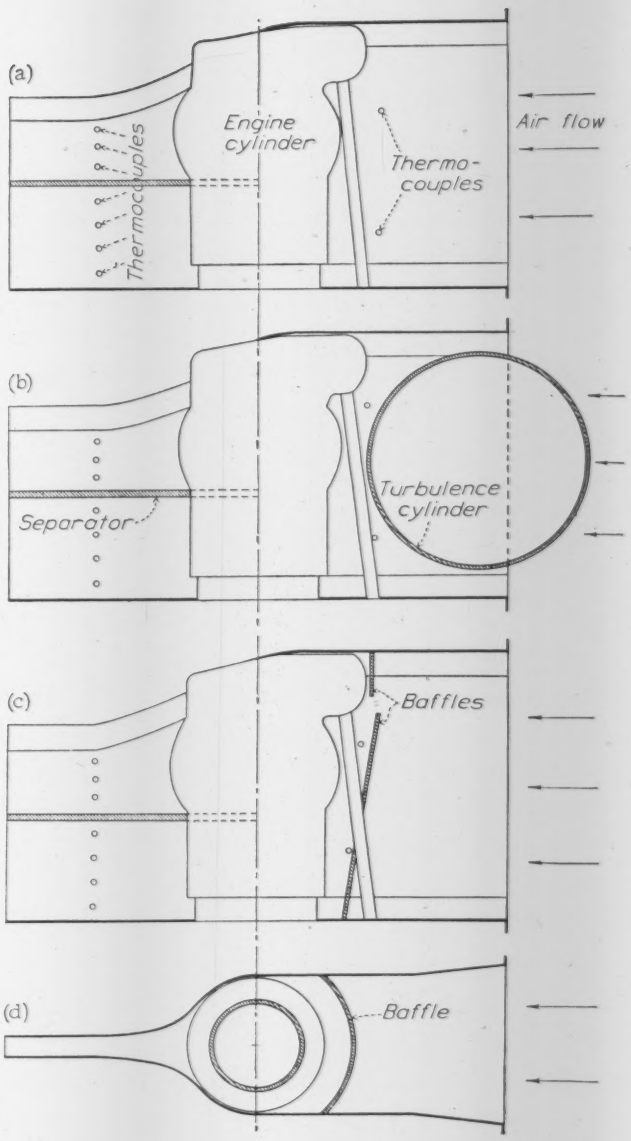


FIG. 1 DIAGRAM OF ENGINE CYLINDER, JACKET, AND TURBULENCE DEVICES

(*a* Engine cylinder and jacket; *b* engine cylinder, jacket, and turbulence cylinder; *c* engine cylinder, jacket, and baffles; *d* section plan view of cylinder, jacket, and baffles.)

where the velocity head was negligible, for measuring the pressure difference between the front of the cylinder and the room.

The quantity of cooling air supplied to the jacket was determined from the readings of a thin-plate orifice tank connected to the inlet of the blower.

The author's conclusions are summarized by him as follows:

1 The heat-transfer coefficient for the transfer of heat from the combustion gases to the cylinder head varied as the 0.68 power of the indicated horsepower for the Pratt and Whitney 1535 cylinder and as the 0.64 power of the indicated horsepower for the Pratt and Whitney 1340-H cylinder.

2 The heat-transfer coefficient for the transfer of heat from the combustion gases to the cylinder barrel varied as the 0.68 power of the indicated horsepower for the Pratt and Whitney 1340-H cylinder.

3 The values of the effective gas temperatures were prac-

tically independent of the engine speed and brake mean effective pressure and for the normal range of operation were equal to 1150 F for the head and 600 F for the barrel for both the Pratt and Whitney 1535 and the 1340-H cylinders.

4 The values of the effective gas temperature (*a*) decreased slightly as the air-fuel ratio decreased on the rich side of the theoretically correct mixture, (*b*) remained constant for a range of spark timing to either side of normal operation and increased for both extremely retarded and advanced spark timing, and (*c*) increased 58 F for 100 F increase in the inlet-air temperature for the Pratt and Whitney 1340-H cylinder.

5 The rate of heat transfer from the head and the barrel to the cooling air varied, respectively, as the 0.35 and 0.31 powers of the pressure drop across the cylinder for the Pratt and Whitney 1535 cylinder and as the 0.34 power for both the head and the barrel of the 1340-H cylinder.

6 The turbulence devices in front of the cylinder provided an increase in the heat-transfer coefficient of the order of 30 per cent for the same pressure drop.

7 For the cylinders tested, in order to maintain a constant cylinder-head temperature for a given cylinder, it was necessary to increase the pressure drop across the cylinder directly as the square of the indicated horsepower.

8 The equations indicate that to improve the heat transfer from the fins by improving the fin design or by using higher air speeds allows the indicated horsepower to be increased as the 1.5 power of the heat-transfer coefficient U with practically no increase in cylinder-head temperature.

High-Pressure Boilers

THE INSTITUTE OF MARINE ENGINEERS

"SERVICE Results With High Pressure Boilers" is the title of a paper by A. L. Mellanby read at a meeting, Feb. 8, 1938, of the Institute of Marine Engineers. Marine types of the La Mont, Velox, Loeffler, Sulzer, Benson, and Schmidt boilers are described and illustrated diagrammatically.

Professor Mellanby shows how, in land use, steam generators of capacities up to a million pounds of steam per hour at pressures in the neighborhood of 1300 lb per sq in. and 900 F, respectively, have been developed, and how the use of pulverized fuel has led to furnaces completely surrounded by tubes containing water or steam, and how the heat transmission by radiation to water in such boilers ranges from 45 to 60 per cent of the calorific value of the fuel.

Contrary to general predictions made some time ago, he says, high pressures and temperatures are now being employed in marine installations, and hence, because of reheating, a further complication is added to the ship's machinery. Special attention must be paid to purity of feedwater, to stresses set up in steam drums of nonsymmetrical section, and to fairly large temperature differences between inner and outer surfaces of the metal.

For the normal boiler estimates show that if heat is being transmitted through an ordinary carbon-steel tube $^1/_4$ in. thick at the rate of 10,000 Btu per hr the temperature difference is from 5 to 6 F. This temperature drop through the metal depends, however, directly upon the coefficient of conductivity of the material from which the tube is made, and it is rather unfortunate that this coefficient for alloy steels is much less than that for plain carbon steels. Taking the coefficient of conductivity K, as measured in Btu per sq ft per min per F per in. thickness, the average values at 212 F for different materials are given as follows:

For 0.26 carbon steel, 6.46; for a carbon steel with 0.5 per cent molybdenum, 4; for stainless iron, 2.9; and for 18/8 chromium-nickel steel, 1.9. It is now common practice to use a molybdenum steel for the high superheats now in daily use, and consequently the temperature drop through the metal for a given heat-transfer rate would be more than 50 per cent in excess of that required with a plain carbon steel. It is necessary to keep in mind this temperature difference between the outer and inner surfaces of the tube, since its effect upon the tube stress is very marked with high rates of heat transmission.

It has been shown by experiment that water is easily capable of taking from the heating surface all the heat that the gases can put into it, and that once the water is circulating over the surface, increase of water velocity has little effect upon the heat-transmission rate. It must be remembered, however, that this refers to water only, and not to mixtures of water and steam. With high rates of heat transfer evaporation will take place rapidly, and in all cases the exit ends of the tubes will contain a water-steam mixture. If too little water is present, overheating will take place unless the velocity is sufficiently high. The importance of a positive controlled circulation where high heat-transmission rates are required is clearly indicated.

Professor Mellanby quotes the following data from a shop test of a La Mont boiler built for a British destroyer:

Working pressure, lb per sq in.	290
Steam generated, lb per hr.	105680
Feed temperature, F.	211
Steam temperature, F.	688
Combustion-chamber temp, F.	2733
Uptake temperature, F.	763
Efficiency (higher heating value), per cent	73.1
Evaporation per sq ft of boiler surface, lb per hr.	21.1

From other figures it is shown that the heat liberation per cubic foot of combustion-chamber volume is as high as 230,000 Btu per hr.

In connection with high heat releases attainable in the Velox boiler because of combustion under pressure, Professor Mellanby says that the figures quoted by the makers rise from 500,000 Btu per cu ft per hr in merchant vessels to 1,000,000 Btu in naval vessels. Gas velocities up to 600 fps are in common use with heat-transmission rates in the evaporator tubes of 100,000 Btu per sq ft per hr. With such high rates of heat liberation and heat transmission, both the volume and the weight of the boiler proper can be brought very low per unit of evaporation, but consideration must be given to the space required for, and the weight of, the circulating pump and boiler.

At present there is only one marine Velox boiler in operation at sea. It has an evaporation capacity of 33,000 lb per hr and generates steam at 230 lb per sq in., 570 F. Figures for an oil-fired land unit at Wellington, New Zealand, are quoted as follows:

Working pressure, lb per sq in. abs.	247
Steam generated, lb per hr.	94800
Feed temperature, F.	122
Steam temperature, F.	630
Uptake temperature, F.	221
Efficiency (lower heating value), per cent.	95.6

It will be remembered that in the Loeffler boiler the heat from the furnace gases at their maximum temperature is received by tubes containing steam alone and not a mixture of steam and water, steam being formed in a separate drum evaporator in which some of the circulated superheated steam mixes with the feedwater. Professor Mellanby quotes figures from *Engineering* to the effect that for 68 tons of steam required per hour for power purposes (1850 lb per sq in., 930 F), with feedwater at

500 F supplied at a rate of 68 tons per hr, the steam forced through the superheater tubes and circulating pump will amount to 220 tons per hr. From estimates of total area for flow the high value of 236 lb per sq ft of area per sec results. The mean velocity of the steam in this section will approximate 60 fps and the pressure drop in forcing steam through the radiant superheater tubes at this velocity will be at least 30 lb per sq in. Steam pressures are in the neighborhood of 1800 to 1900 lb per sq in., and the outlet temperature of the steam is about 900 F. Figures relating to a recent voyage of the S.S. *Conte Rosso* indicate an efficiency of about 90 per cent, a pressure of 1900 lb per sq in., steam temperature 896 F, feedwater 248 F, and flue gas at uptake 302 F.

A drumless once-through Benson boiler has been in continuous service in the S.S. *Uckermark* since 1930, and others of this type have been installed in other ships. Critical-pressure operation has given way to working pressures of 1154 lb per sq in. In the *Pretoria* and *Windhuk* two Benson boilers are installed. Under normal load conditions each boiler produces 61,600 lb per steam per hr at a pressure of 1154 lb per sq in., 842 F temperature. From service records it is estimated that under normal loads the efficiency of the boiler is 91 per cent and the oil consumption for main engines and auxiliaries is 0.617 lb per shp-hr.

The drumless "monotube" Sulzer boiler is said to have a tube length of the order of 30,000 times the internal diameter of the tube. Water in the generator is treated either continuously or periodically. The only Sulzer marine monotube boiler was installed in the S.S. *Kertosono* in 1936, is oil-fired with an output of 44,000 lb of steam per hr at a pressure of 850 lb per sq in., and a temperature of 715 F. A collision laid up the ship after 3500 working hours.

The unique feature of the Schmidt boiler is its dual circulation system; a primary system filled with distilled water, the steam from which circulates continuously through coils in a secondary drum where working steam is evaporated. The advantage of doing away with the necessity for special feedwater treatment is obvious. Forty-eight Schmidt type boilers are in service on land and one was installed in the S.S. *Altair* in October, 1937, consisting of two separate boilers, each with an output of 9260 lb per hr. The pressure in the secondary boiler is 740 lb per sq in., temperature 900 F. Shop tests indicate an efficiency of 87 per cent.

Measuring Diesel Performance

SULZER TECHNICAL REVIEW

ELECTRICAL measurement methods are now being applied by Sulzer Brothers in the development of Diesel engines, according to a description of the process in the *Sulzer Technical Review*, No. 4, 1937. Rapidly recurring changes of pressure or the relative movements of engine parts can be recorded, even at points not easily accessible, by means of electric transmitters, which convert mechanical movement into voltage in an electric circuit. After being amplified, or otherwise modified, these voltages are recorded photographically on an oscillograph.

Basing their wiring plan on that proposed by Kluge and Link in a paper published in 1930 in the *Zeitschrift des Vereines deutscher Ingenieure*, the company has built a portable measuring apparatus consisting of three distinct units.

The first unit consists of the electric transmitters which are similar to induction coils. The tendency at present is to keep these transmitters as small and simple as possible, insensitive to vibration, and reliable. Whenever possible, the transmitters are built for universal application; but in several cases it was found necessary to make special sizes and types.

The second unit consists generally of amplifiers, which strengthen the feeble impulses sent out by the transmitters and thus make them capable of actuating the recording oscillographs. Devices for differentiating and integrating the curves obtained are contained in the amplifier.

The third unit of the apparatus is the oscillograph in which luminous rays are controlled by the amplified voltages from the transmitters, thus enabling a photographic record to be taken. For this purpose multiple oscillographs have proved particularly useful, since they allow as many as six distinct phenomena

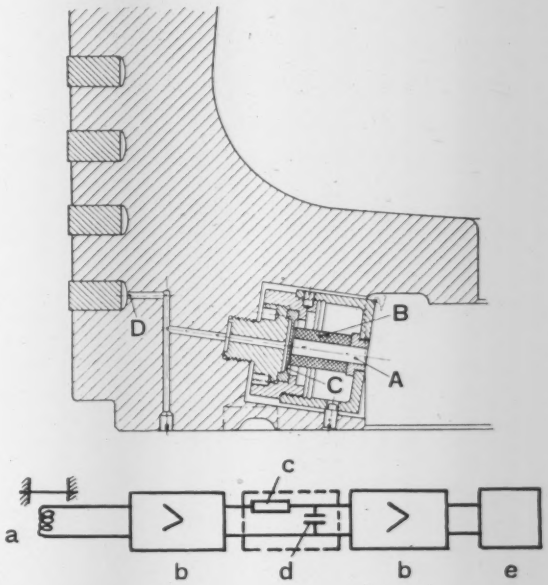


FIG. 2 PLACING OF INDUCTIVE TRANSMITTER IN PISTON AND INTEGRATION WIRING ARRANGEMENT FOR RECORDING PRESSURES BEHIND THE PISTON RINGS

(*A* permanent magnet, *B* induction coil, *C* steel membrane, *D* bore communicating with transmitter, *a* transmitter, *b* amplifiers, *c* resistance, *d* condenser, *e* oscillograph.)

to be recorded simultaneously, so that the connection between the separate phenomena can be investigated on one oscillogram.

The manifold uses to which this apparatus may be put can best be seen from some of the measurements made on a single-cylinder experimental Diesel engine and described in the article. After finding the upper dead center of the engine, with the equipment, such applications as finding the amount of bending in the piston crown caused by gas pressure, recording the pressures behind the piston rings, and measuring the axial movement of piston rings are explained and illustrated with oscillograms.

For measuring the variation in pressure in the grooves behind the piston rings, the wiring arrangement and six inductive transmitters for pressure records fitted in the upper part of the piston, as shown in Fig. 2, were used. The steel plate *C* is deflected by the gas pressure. The permanent magnet *A* generates a magnetic flux through the casing and steel plate, and this is modified by the air gap between the plate and magnet. Alteration of the air gap causes a change in the magnetic flux, which generates an induced current in the spool *B*. The induced current is proportional to the rate of change of pressure (dp/dt) and is integrated electrically, a resistance of 5 megohms and a

capacity of 4 microfarads being inserted between the first and second stages of the amplifier.

To avoid capacity changes due to the piston travel the cables connecting to the spools were arranged in a tubular metal screen arranged in a link and lever gear.

Tandem Airplane Propellers

SCIENCE NEWS LETTER

HIGH-SPEED airplanes of the not-too-distant future may be pulled through the air by the whirling blades of tandem propellers mounted close together, one behind the other, and rotating in opposite directions on concentric propeller shafts, according to an article in the Feb. 26, 1938, issue of *Science News Letter*.

Forced by the growing size and weight of propellers needed to deliver the full power of even larger engines, Brig. Gen. A. W. Robins, chief of the Matériel Division of the Air Corps, reports that U. S. Army aeronautical engineers at Wright Field, Dayton, Ohio, are experimenting with a set of such propellers of the fixed-pitch type and are planning the construction of two controllable-pitch sets for further study. Construction of the propeller shafts, involving one shaft inside the other and rotating in opposite directions, is a difficult problem.

Propellers needed on the most powerful planes flown by the U. S. Army Air Corps are now 13 ft in diameter and are relatively heavy. The engines in use today have about reached the limit in size of the accompanying propeller, and more powerful engines contemplated by engineers and certain aviation developments of the next few years will require larger propellers still. The tandem propeller scheme is one possible attack on the problem of cutting down the size of the whirling blades. Two propellers mounted 8 in. apart in tandem style would cut the size of the propeller in half.

The world airplane-speed record, 440.681 mph, set by Lieut. Francesco Agello, of Italy, in October, 1934, is held by the only tandem-propelled plane now flying. Designed to compete in the Schneider trophy races in England in 1931, the ship was not completed in time and was used instead for several successful assaults on the speed record. No other such plane is known to exist.

Pneumatic Telemetering

INSTRUMENTS

THE REMOTE transmission of instrument readings by electrical means and hydraulic systems is well known in industry. Now, according to Coleman B. Moore, development engineer, The Brown Instrument Company, in an article in *Instruments*, September, 1937, a system has been developed for the remote transmission of low-rate readings by pneumatic means. He shows how this method can be adapted to telemetering pressure and temperature.

Fig. 3 shows the construction of a pneumatic flow-rate transmitter with a lever making possible square-root conversion giving a uniformly graduated scale. The flowmeter shaft, operated from a float in a conventional mercury manometer, rotates for full scale through an angle represented by *A*. The transmitter bellows must therefore operate through its connecting rod to move the flapper-actuating mechanism through the same angle. The spring and bellows are so proportioned that a change in pressure from 2 to 10 lb per sq in. will accomplish this motion.

The flapper-actuating mechanism consists of a shaped lever *B'* and a lever *G*. The shaped lever carries another lever *D*, pivoted at *E*. To the lower end of lever *D* is attached a link connected to the arm from the flowmeter shaft, and the upper end of the lever carries a projecting pin *F*, which operates the flapper.

In operation, a counterclockwise motion of the arm from the flowmeter shaft (corresponding to an increase in flow) moves the lever *D* about its pivot *C*, causing the flapper to rest on the nozzle and build up the pressure in the bellows chamber. The compression of the bellows moves lever *G* which in turn actuates the shaped lever *B* to restore the flapper to a position slightly closer to the nozzle. This balances out the mechanism at a proportionately higher pressure, bringing the system to equilibrium.

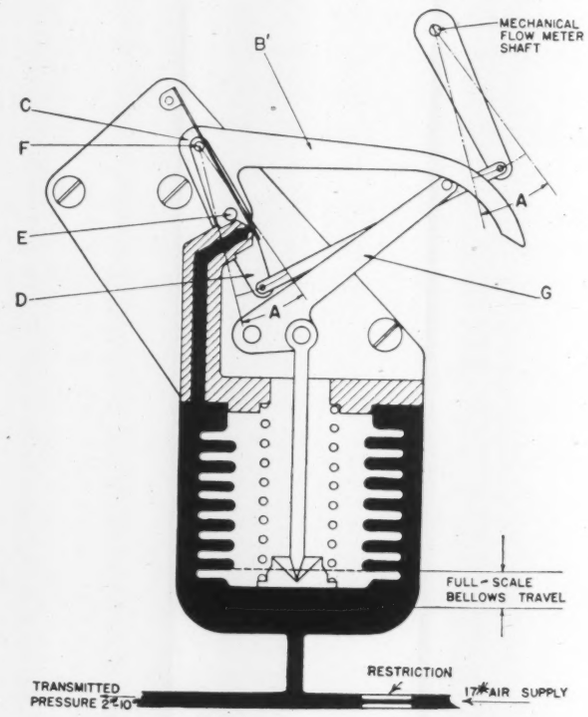


FIG. 3 PNEUMATIC TRANSMITTING UNIT WITH SQUARE-ROOT CONVERSION GIVING UNIFORMLY GRADUATED SCALE

In actual operation, these motions occur simultaneously, so that the flapper-actuating levers work as a unit and move through the same angle, following the motion of the flowmeter shaft arm. The unit is capable of extracting the square root of the pressure differential across the orifice, and transmitting flow readings on an evenly divided scale. It is interesting to note that in this unit, where the pneumatic amplifications are the greatest (near zero flow), the contact angle of the levers is at a minimum. This illustrates how the pneumatic system produces a relatively high multiplication of motion with mechanical forces that are relatively low.

The pressure connections consist simply of a regulated and filtered 17-lb per sq in. air supply connected through a restriction to common connections to the transmission tubing, bellows chamber, and nozzle. The restriction is smaller than the nozzle opening, so that when the flapper is about 0.004 in. from the nozzle, the pressure will drop to 2 lb per sq in., and when it

is about 0.001 in. away, the pressure will rise to 10 lb per sq in.

The receiver may consist of a pressure gage of any suitable size, form, etc., indicating, recording, controlling, or combination, calibrated in the units measured at the transmitting station. Transmission of readings from the transmitter to the receiver has been made through tubing measuring several hundred feet in length. For pressure or temperature transmission, it is merely necessary to replace the manometer in the transmitting instrument with the required measuring element.

Powder Metallurgy

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

THE IMPORTANCE of powder metallurgy in present-day industry was demonstrated at the annual meeting of the American Institute of Mining and Metallurgical Engineers in New York when an all-day symposium was held Feb. 17, 1938, to discuss the subject. Six papers, tracing the development of the art to its present utilization in the production of ductile tantalum, columbium, molybdenum, cemented tungsten-carbide alloys, and tantalum-carbide tool compositions, were presented individually or jointly by Charles Hardy, D. O. Noel, J. D. Shaw, E. B. Gebert, G. J. Comstock, C. W. Balke, W. P. Sykes, and P. M. McKenna.

To define powder metallurgy, one of the speakers used the definition given by Prof. C. C. Furnas of Yale University in the report, "Technological Trends and National Policy," issued by the National Resources Board, June, 1937. Professor Furnas says that it is the art of producing a formed product from powders by hot or cold compression, which, upon subsequent heat-treating, shows characteristics not generally obtainable by orthodox processes. It is roughly analogous to the technique employed in the field of plastics and started with the preparation of tungsten and molybdenum wires by the electrical industry.

The powders of the metal to be used must be carefully controlled as to particle size, purity, and mixing. They are molded under high pressure and sintered (incipient fusion by heating and compression) in an electric furnace with a reducing atmosphere. Temperatures are maintained at about two thirds the melting point. These sintered metals produced by the process of powder metallurgy are now used in millions of bearings and bushings in automobile and railway cars, in dental work, electrical parts, welding rods, and metal-cutting tools.

All of the speakers elaborated on this definition and told how the process has produced the strongest of metals, tungsten; the hardest of the alloys, hard cemented carbides; the porous bearings, some with one or two million pores to the cubic inch; and the mechanical union of unalloyable metals, electrode and contact materials. Powder metallurgy is said to afford a means of obtaining extremely high purity, easily applying vacuum or controlled gas atmospheres, developing further desirable structural or localized composition effects, eliminating cast structures and addition of undesirable materials to promote casting, and forming materials difficult to forge or cast, and, in some cases, producing articles cheaper than they can be made by other methods.

The metal powders utilized in the process are produced by a great many methods, the chief of which are, reduction by gas, electrolysis, vapor condensation, and atomizing.

Up to now the products formed from metal powders have been small in size because, with few exceptions, the pressures required lie between 15 to 50 tons per sq in. In order to obtain the required porosity or density, it will readily be seen that presses now available and operating economically would not permit the production of pieces with a surface area of many square inches or parts of great depths, since the average apparent density of metal powders is about 30 per cent of the density of cast metal. Therefore, a ratio of compression of 3 to 1 must be used.

Besides these mechanical difficulties, there are the chemical and physical difficulties. The combination of three, four, or more metals of various densities and melting points still offers a number of problems that, while on the way to solution, cannot be termed as entirely solved to the satisfaction of the user.

Types of current metal-powder products include materials which can only be fabricated or worked as powders, such as, the highly refractory metals, tungsten, molybdenum, and tantalum, the hard cemented tool materials, the porous bearing materials, and the electrode and contact materials. Other types include materials which can be made by other means but which can be more efficiently produced from powders, such as, materials which are forged or cast with difficulty, for example, permanent magnets, high-purity material from which it is desirable to exclude additives to promote casting, iron-nickel-cobalt alloy, titanium copper, small parts and coins which require excessive machining or which involve considerable scrap in their production, composite parts or articles which can be made from powders more easily by localizing composition effects, and magnetic alloys or thermostatic alloys which are adversely affected by cast structures.

Recent Tractor Developments

LOUISVILLE SECTION, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ABOUT 244,000 tractors with a value of approximately $184,000,000 were sold in the United States during 1937. Of the two general types sold, the wheel type included 72 models manufactured by 15 manufacturers and the track-laying type consisted of 35 models made by four manufacturers, three of which are also included in the wheel-type category. In a paper presented at a meeting of the Louisville Section, A.S.M.E., Nov. 15, 1937, Ray Haselberger, a Junior member, traced the development of the four-wheel-type tractors during the last decade.

Among some of the developments mentioned by him was the design of a special cultivating tractor which must have a high clearance in order to straddle rows of crops. A number of ingenious designs were devised to permit changes for crops with center spacing varying from 26 to 44 in. Splined or keyed axles, to which the wheels were clamped, was one design. The latest design, is a large hub with several rows of lugs which makes possible as many as six or eight wheel spacings.

To enable the lifting of the heavy farm equipment developed for use with modern tractors, it became necessary to provide a means to use power furnished by the tractor itself. Two classes of power lifts were developed, mechanical and hydraulic. The mechanical power lift incorporates a clutch having a motion of 180 deg when engaged with the driving worm gear. To provide a lighter and more compact lift than the mechanical type, the hydraulic lift was designed. It is either of the piston or gear type driven from either the transmission or one of the accessory drives of the engine.

From 1932, the use of rubber tires on agricultural tractors began to grow until in 1935, 20 per cent of tractors sold were equipped with them and in the last year, the number exceeded 50 per cent. In view of the fact that rubber tires add from 20 to 40 per cent to the initial tractor price, this indicates an interesting trend. Advantages claimed for rubber-tired

tractors are cushioning of shocks which eliminates breakage and reduction of rolling resistance of the tractor which means a considerable saving in fuel. Another advantage is the higher speed which is possible. In order to prevent slippage of the rubber-tired wheels, weight is added to the wheels by partly filling the tires with water or attaching iron weights. Disadvantages which have tended to decrease the potential market for tractor tires are the additional cost and the inability to use them with success under all conditions.

Self-starters have been applied to agricultural tractors and from present indications, their use will expand. In many sections of the country during the proper season, plowing, cultivating, and planting are carried on day and night until the work is finished. Therefore, some tractors are equipped with focusing headlights.

Today, tractors are built with two-, four-, and six-cylinder engines. However, the four-cylinder engine is probably the most popular, although there has been a recent trend toward six-cylinder power plants, in all but the smallest tractors. In many cases, automotive truck engines have been used with varying success. Engine speeds of tractor engines approximate 1250 rpm, varying in some cases between 400 and 2000 rpm. Of the 72 wheel-type models manufactured, only two are equipped with Diesel engines. Until the time comes when this type of engine will not cost four to seven times as much as other internal-combustion engines developing the same power, it appears unlikely that there will be any general trend in this direction.

Perhaps the most desirable feature in tractor engines is simplicity. Formerly overhead valves and removable cylinder liners were considered very necessary in engines of this type. However, experience and the use of air filters have proved their impracticability. Crankshafts are generally proportioned for maximum rigidity and bearing pressures are kept as low as space will permit. Excellent results have been achieved by using a ball or roller bearing on each end of the crankshaft.

The kind of fuel used depends upon the locality and individual preference. In general, the most popular fuel is distillate, with gasoline following. Kerosene and furnace oil are also used to some extent. It is the usual practice to start the tractor on gasoline and then run it on one of the other fuels mentioned. For this reason, most tractors are furnished with two fuel tanks. In engines using distillate, a special type of intake manifold, with an adjustable by-pass and heated by the exhaust gases, is used.

Tractors may also be classified according to frames; in one a separate frame is provided upon which is mounted the engine, transmission, and the rear axles; in the other there is no frame except a backbone provided by the transmission to which is bolted the engine at one end and the rear axle housing at the other end. From the standpoint of simplicity of manufacture and accessibility for making repairs and major adjustments, the former type is best suited. However, the frameless type of tractor lends itself to many advantages from a designing viewpoint. Any scheme of gears can be worked into the transmission with a varied arrangement of speeds. Relatively large reductions can be made in the final drives which results in a lighter differential and transmission, and various weight distributions.

Tractor transmissions usually have three, four, or five forward speeds, and either one or two speeds in reverse gear. In some of the latest tractors using rubber tires, standard truck transmissions have been used with varying degrees of success. At some point in the transmission, provision is usually made for driving a belt pulley by the use of a pair of bevel gears. The final drive is usually made through two sets of spur gears which helps to reduce the load that the differential and bevel gears must transmit. If the spur gears are located at the outer ends of the axle housing, the vehicle is called a bull-gear-driven tractor. If the gears are inside of the transmission case, it becomes known as a straight-axle tractor. Because of the simplicity of construction of the latter type, the trend in recent years has been toward this arrangement. However, extra-large drive wheels must be provided to obtain the needed clearance between the axle housing and the ground.

Differential brakes are usually provided on each of the driving axles, the purpose being to provide a means of pivoting the tractor in a small radius. These brakes may be operated individually or simultaneously by foot or hand levers. The method of brake control is determined by the type of clutch used; if the clutch is hand-operated, then the brakes are operated by foot, and vice versa.

Trends in Railroad Research

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

CITING many examples and figures of the advances made by railroads in the last three decades in equipment design and construction, D. S. Ellis, member, A.S.M.E., chief mechanical officer, Chesapeake & Ohio Ry., in a paper presented at the A.S.M.E. Fall Meeting at Erie, Pa., Oct. 4–6, 1937, brings out the need of continuing this trend by means of further research. He groups and defines research under three headings, namely, fundamental research which is done without commercial motive, creative research which develops new and improved commodities, and applied research which deals with the ways and means of applying results of creative research. It is appropriate to point out the fact that there has never before been as much of an opportunity for railroads to make such important research and engineering contributions toward improved efficiency and better transportation as there is today.

The direction in which these contributions can be made, may be grouped under three headings:

(1) The prime movers, especially the steam locomotive which is the most widely distributed and effective unit
(2) The rolling stock, passenger, and freight
(3) Maintenance of equipment, including facilities for such work.

In the first group, the steam locomotive has and will develop in many ways. Among these developments are, first, a detail study of the principles of combustion as applied to locomotive practice and a consideration of boiler pressures within the practical limits established by peculiarities of locomotive service; second, the practical application of those relations between firebox volume, firebox and tube heating surface, and grate area; and third, increases in driving-wheel diameters, piston speeds, and improvements in the design and material used for machine parts.

The second group of equipment to which research may probably be devoted, may be divided into two classes, passenger and freight cars. The trends in design and construction which have been evident during the last two years, and which owe their origin largely to a critical public attitude, have, nevertheless, been of a constructive nature. It is certain that these developments will exert a permanent influence upon the design and construction of passenger equipment in the future, leading to radical departures from past practices, especially regarding weight reduction, and toward refinements contributing to appearance, comfort, and convenience. The growth in the use of alloys and

the economic necessities of the railroads, coupled with commercial activities, have also been effective in creating a tendency toward weight reduction in freight equipment. With the further application of engineering research, a practical form of construction will be developed that will satisfy general transportation requirements, the conditions imposed by current operating trends, and the effects of ordinary service conditions upon car structure.

The aims to be accomplished in the directions thus briefly outlined, will not be reached unless they are attained with appropriate regard for the third group, maintenance of equipment. The general trend of maintenance expense follows generally the cost of production in other lines, and this can be offset only through a reduction in the repairs and replacements required. It is suggested that there may be mass-production processes, now being successfully employed in other industries, that might be adapted to the ordinary routine of equipment repair operations with advantage alike to the railroads and to those who are promoting the use of such processes elsewhere.

Flame Softening

OXY-ACETYLENE TIPS

FLAME SOFTENING is not unlike flame hardening which was described in this section in the November, 1937, issue, in that it is a localized and progressively applied marginal heat-treating operation effected by means of multiflame oxyacetylene heating heads. However, in purpose and in metallurgical aspects, according to a description of the newer process in the February, 1938, issue, of *Oxy-Acetylene Tips*, it is exactly opposite to flame hardening.

The object of flame softening is to remove the undesirable hardness which results from cutting some of the low-alloy, high-strength steels with an oxyacetylene flame. The process is dependent upon the fact that most steels are relatively soft when annealed from above the critical point or tempered below the critical point. In flame softening, the multiflame heads provide sufficient additional heat to the body of the metal so that the cooling rate of the cut surface is considerably slower than it is with plain flame cutting.

The line of demarcation between steels which do and do not require the flame-softening treatment cannot be gaged by a single yardstick. Different grades of steel do not act the same way physically in going through the cutting process. However, for plain carbon structural steels, those above 0.30 to 0.35 per cent carbon may require to be flame-softened. Also, most of the high-strength, low-alloy structural steels are hardened by plain flame cutting and require the flame-softening treatment. Typical of this group are the nickel, manganese, and silicon structural steels.

Most flame-softening treatments are carried on simultaneously with the cutting operation, the method involved depending on the thickness of the metal cut and whether the steel is of the quench-hardening or air-hardening type. Air-hardening steels must be postheated, that is, the heating head follows along after the cutting blowpipe. Quench-hardening steels are readily softened either by preheating or postheating. However, the postheating treatment is preferable.

There are three methods used in flame softening. The first method, using a single multiflame heating head at the top of the cut edge, either directly before or after the cutting tip, is for plate thicknesses up to 3 in., depending on the degree of softness required. The second method is for thicknesses from 1 in. to approximately 4 in. and is similar to the first method with the exception that an additional multiflame head is directed at the bottom of the cut edge.

As the gage of the metal increases, it becomes more difficult to carry out the simultaneous heating operation, due to the inaccessibility of the metal deep in the narrow kerf or slit. Therefore, the third method which has a range from $1^1/_2$ in. up, is applied directly to the face of the cut edge after the scrap has been removed or the kerf opened to admit the softening apparatus. The treatment is applied before the cut surfaces cool to room temperature.

The heat is provided by either 7-flame or 30-flame water-cooled heads which are the same as are now being used for flame-hardening operations. Since a neutral flame is employed, the multiflame heads consume approximately equal quantities of oxygen and acetylene. The volume of oxygen and acetylene for softening a plate 1 in. thick by the first method may be figured at approximately 2 cu ft of each gas per linear foot of cut for each side of the kerf softened.

Pulverized-Coal Locomotive

GERMAN RAILROADS

ONE OF THE special-type locomotives mentioned in the article, "Progress in Railroad Mechanical Engineering in 1937," appearing in the December, 1937, issue of MECHANICAL ENGINEERING, was the new German 4-6-4 high-speed locomotive with pulverized-coal firing and the cab in front, completed in July, 1937, on the occasion of the Borsig Locomotive Works' 100th anniversary.

As seen in Fig. 4, the new locomotive is streamlined in ac-

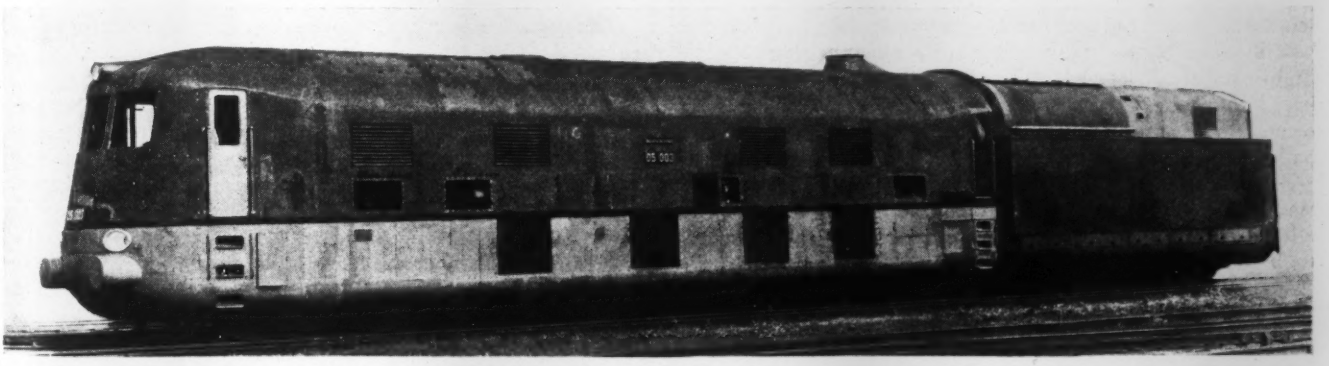


FIG. 4 GERMAN RAILROADS' STREAMLINED PULVERIZED-COAL EXPRESS LOCOMOTIVE

cordance with the results obtained in wind-tunnel tests. It belongs to the construction series "05" and is a 2–C–2 engine with driving wheels of 7.55 ft diameter. Like two earlier German 4–6–4 streamliners, it is designed for a speed of 109 mph. The smokestack is just front of the tender from which pulverized coal is carried to the cab in front where the fireman, aided by automatic control apparatus, is able to feed the fire by pressing buttons. The large, wide windows across the entire front of the cab provide the engine driver with an uninterrupted view and give the locomotive the outward appearance of a streamlined Diesel-electric locomotive.

Rubber Bearings

INSTITUTION OF MECHANICAL ENGINEERS

RUBBER has been found suitable for use as a bearing material where relatively low frictional resistance is required, according to a paper submitted by Sydney A. Brazier and W. Holland Bowyer at a general discussion on lubrication and lubricants, held at the Institution of Mechanical Engineers in London, October, 1937. Discussing the results of experiments with various bearing materials, the authors show how rubber, being flexible and deformable, can accommodate itself to surface irregularities without destroying the continuity of the water lubricating film, and in this way the surfaces of the bearing can be kept separated by a film of lubricant which is less than that necessary for equivalent metal surfaces.

In any revolution of the shaft each single point will pass over one or more of the faces of the water-lubricated rubber bearing which are separated by grooves. As the edge of each face is rounded, and owing to the resilience and deformability of the rubber, the load on each face will vary from zero to a maximum value. Because of this, the lubricating film of water is formed at a point of low pressure, and, because of its low viscosity in comparison with oil, when this film is once formed, it is dragged by its adhesion to the shaft through the length of the face, provided the speed of the shaft is in excess of a critical value depending on various conditions.

The advantage which rubber possesses in this way is considerably increased when the water used for lubrication contains grit or dirt. Owing to the ease with which the rubber is displaced and its resilience, the particle of grit does not lodge in the bearing, but is depressed into the rubber without cutting, and is then rolled by the rotation of the shaft into the adjacent groove, and so washed away. In addition, owing to this deformation, the unit load on such particles approximates that on the surrounding rubber, whereas on a hard-surfaced bearing the load will rise to a considerable value before it is forced into the bearing or shaft surface. It therefore follows that any scoring action in a rubber bearing is considerably less than that possible for a hard-surfaced bearing, and that the shaft remains highly polished, instead of becoming deeply scored and, perhaps, grooved. Furthermore, this advantage of rubber is not secured by the sacrifice of life, oftentimes metal bearings being outworn by the rubber types.

Several types of rubber bearings have been developed, the main differences being found in the design of the rubber lining with regard to its effect on the passage of the lubricating water. Its hardness will depend on the general conditions of use, particularly the bearing load. A very hard rubber is unsuitable, as in addition to its being readily cut away by particles of sand or grit, the coefficient of friction obtained more nearly corresponds to that obtained with metal bearings. The rubber used must be resilient, tough, resistant to cutting and wet abrasion, while its permanent set must be as low as possible. In addition, it should be of such nature that, if necessary, it can be ground accurately to size with a suitable fine surface.

The requirements for the successful operation of rubber bearings are briefly as follows:

(1) The size of the bore must be accurate and give sufficient clearance for an easy running fit.

(2) Owing to the low heat conductivity of rubber, any frictional heat must be carried away by the lubricating water. A continual flow of cooling water is therefore imperative. The bearing must never be run dry, even at starting.

(3) The shaft and the bearing surfaces must be smooth and unscored.

(4) The lubricating grooves must be placed sufficiently close together, so that the temperature of the water film is not raised excessively.

(5) Oil and grease, especially mineral oil, even in small quantities, can often be detrimental to rubber bearings and cause "tackiness." It is possible by suitable compounding, to give the rubber considerable resistance to oil.

Rubber has been used successfullly over considerable periods of use in underwater marine work, high-speed motor boats, hydraulic turbines, centrifugal pumps, agitators, washing machines, and domestic and industrial liquid-handling equipment. For pumping systems dealing with drinking water, and many solutions or fluids used in the preparation of foodstuffs or beverages, rubber forms an ideal bearing material.

Ceiling Heating Systems

SULZER TECHNICAL REVIEW

A METHOD of heating rooms by means of hot-water pipes embedded in the ceilings has been developed and installed in apartment houses, schools, and factories in Switzerland and France by Sulzer Brothers, Ltd., according to an article in the *Sulzer Technical Review*, no. 4, 1937. The term, "panel warming" is applied to this system which utilizes the principle of radiation.

The difficulties encountered in installing radiators under windows, and also the blackening of walls and ceilings due to the particles of dust charred and circulated by the heat currents, initiated the experiments to use floors and ceilings of rooms as heating surfaces. With floor heating, it was found that even with the temperature of the floor only a little higher than the room temperature, a certain amount of discomfort was caused to the occupants' feet and bodies. Moreover, floor heating does not eliminate convection currents, and since the surfaces which give off heat are situated at the lowest part of the room where dust is most likely to exist, the results were unpleasant.

The characteristic features of heating by pure radiation could be obtained only by transferring the heating surfaces to the ceiling. Apart from the lighting fittings, the ceiling is absolutely free for this purpose, and here, a slightly higher temperature will not make itself directly and disagreeably felt by persons in the room, as in the case of floor heating. The heating surfaces in the ceiling are everywhere at the same distance from persons in the room, whether by the windows or near the inner walls.

Because of the moderate temperature of the water used in the system, not only the heating coils in the ceiling but also all the distributing pipes may be embedded in concrete. In this way, the heating coils form an integral part of the reinforced concrete ceilings, thereby saving the weight of the usual iron reinforcements. Before the concrete is poured, the pipes are sub-

mitted to a test pressure of about 400 lb per sq in., so that the smallest defect is made apparent before the coils are finally covered up.

Ceiling panel warming is advantageous in that it prevents a stirring up of dust by hot air movements. It has been proved by experimentation that in heating by radiation from the ceiling, the temperature of the air in the room is slightly lower than the temperature of the floor and walls. This gives much greater comfort than heating by ordinary radiators, which must raise the temperature of the air in the room 2 to 4 F higher to make the air comfortable. It is a physiological fact that a person feels more comfortable when he can give up a part of his warmth to the surrounding air and in return receive a certain amount of radiant heat, than when the difference in temperature between his body and the surrounding air is only slight.

With radiator heating, a maximum water temperature of 175 to 195 F has to be used while with panel warming 120 to 130 F has been found satisfactory. The low water temperatures also have the advantage that the loss of heat in the piping is less and thus a saving in cost can be made in insulation and fuel.

The value of a ceiling-panel-warming installation is greatly increased by the possibility of using it in summer for cooling the rooms by circulating cold water through the pipes. Hitherto, for cooling in summer, a special ventilating plant had to be installed, entailing considerable cost not only for the plant itself but also in connection with the alterations required in the building, in order to provide the necessary air ducts. Comparative tests have shown that, with panel cooling, a room facing south can be kept at about the same temperature as when connected to a central ventilating plant working with refrigerated air.

The only extra cost entailed for adapting panel warming for use as panel cooling, is the installation of a countercurrent apparatus in which the water circulating in the system is cooled indirectly by cold water or other cooling medium.

Continuous Hardness Test

METALLURGIA

TO FACILITATE the study of agehardening, which is such an important attribute of modern light alloys, a new hardness tester has been developed which produces continously and automatically a permanent record covering as many days or weeks as might be desired. The apparatus was designed by Edward G. Herbert, member, Institution of Mechanical Engineers, and is described by him in an article in the September, 1937, issue of *Metallurgia*, the British journal of metals. A diagram of the apparatus is shown in Fig. 5.

The specimen *A*, $1^3/_4$ in. in length, is mounted in carriage *B*, consisting of a shallow brass box containing a corrugated strip of lead and a mass of plasticene. The specimen, lapped flat and polished, is pressed into this matrix, which holds it firmly and is capable of withstanding pressure. The carriage containing the specimen is pressed upward by the loaded ball bearing *C* against the flat surface of a hard-steel bush *D*, rigidly mounted in the apparatus. The carriage is suitably guided, and is moved longitudinally by the feed-screw *E*, rotated by clockwork, and making one revolution per hour. The pitch of the feed-screw is $^1/_{38}$ in., and the time occupied in traversing the specimen from end to end is 66 hr. The time of traverse can be shortened or extended without limit by suitable gearing. A load *W* and a movable poise *F* are mounted on a beam *G*, graduated in kilograms and supported at one end on the long knife-edge *H*. A grooving tool *J* is attached to the beam and, passing through the hole in the bush *D*, rests on the traversing specimen with a predetermined load.

Angular and pointed grooving tools are incapable of giving useful information about aging changes. The action of the angular tool is that of a double plowshare, displacing metal from the furrow and depositing it in a ridge on either side. This drastic deformation so changes its characteristics that the dimensions of the scratch may have little correspondence with the properties of the metal in its original undeformed state. Therefore, a new type of grooving tool was developed. In this tool a steel ball, 1 mm in diameter, is placed in a hard-steel socket, as illustrated in Fig. 5. The ball rests in a highly polished spherical cavity, part of which is cut away to reduce friction. Under the combined vertical load and horizontal traversing force, the ball penetrates the surface of the specimen and, rotating, rolls a groove in it. The ball is slightly roughened by

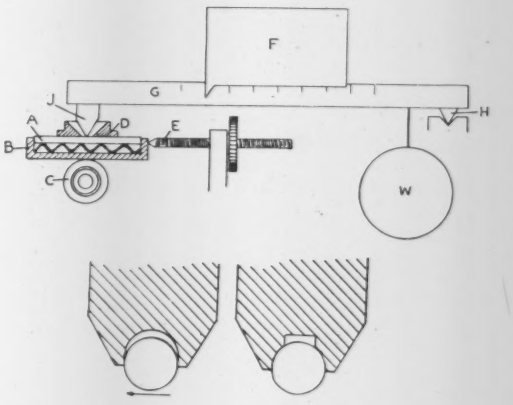


FIG. 5 CONTINUOUS HARDNESS TESTER AND GROOVING TOOL

etching with nitric acid to give it a grip on the specimen and to obviate slip, while the etched ball forms a groove with a matt surface easily distinguished under the microscope.

The rolling-ball test is in effect a continuous Brinell test, and the dimensions of the groove (depth and width) constitute a permanent record of hardness changes occurring during the formation of the groove. A transparent scale graduated in hours is attached to the specimen alongside the groove, so that the hourly graduations can be read together with the corresponding width when the groove is projected at 100 magnification on the screen of a metallurgical microscope. In order to convert the width of the groove into Brinell hardness, the ball is allowed to rest on the stationary specimen for 30 sec under the test load of 5 kg so as to form an indentation from whose diameter the Brinell hardness can be calculated. Three such Brinell impressions are made at the beginning of the test, and at the end, and at one or more intermediate positions during the test. For continuous hardness tests in hard steel, a rigidly mounted diamond, having a hemispherical surface 1 mm in diameter, with a load of 5 kg, is used.

A large number of cases of periodic hardness fluctuations have been investigated. The changes have been found to be induced by thermal, magnetic, and mechanical disturbances of the metallic structure, and no matter which of these three methods of disturbance has originated them, they have the same general character, similar periodicity and amplitude, and they have this further attribute in common—they can be stabilized at either a maximum or a minimum phase by placing the specimen for a few minutes in a constant magnetic field. The view is therefore taken that the fluctuations are electromagnetic, and

as such they may be regarded as an extension at the low-frequency end of the long series of electromagnetic pulsations of which heat, light, and wireless waves are the most familiar examples.

Lumber Advances

INDUSTRIAL BULLETIN

THE MOST revolutionary advance in the history of the lumber industry may now be in the making at Mobile, Alabama, according to an article in the December, 1937, issue of the *Industrial Bulletin* of Arthur D. Little, Inc. Compounded wood, uniform as to weight, strength and, to a reasonble degree, color, is the product of a large-capacity plant which started operations in December. Compounding of wood is the term applied to the process of peeling veneers to given thicknesses, drying them, and gluing them together to produce what is ordinarily known as plywood. No similar effort in the past has been made to compound woods for specific physical properties.

The basic principle of the new compounded lumber is simple, but far-reaching in its possibilities. Woods unsuitable for many construction uses become the core, and other types of wood become the covering or face, in such proportions as will give a board complying to specifications. The compounded wood is to be marked with a light "blonde" surface, to permit uniformity of color. Thus there can be prepared from the major species of forest and even jungle woods, boards having within 5 per cent of the same elastic moment, and thus the same properties for the uses intended.

The practice of veneering is old; the contributions of the new process are based on veneering technique, but are carried far beyond present practice. Logs of various types are fed into a great "boiling" pool and soaked the proper time to permit greater ease in peeling the veneers. The logs are then fed to a new-style high-speed peeling lathe, from which the ribbon veneer passes to an accurate, automatic electric clipper, to be clipped to uniform size, and thence to a conveyor which drops it selectively into "books" of desired combinations of heavy and light sheets. The sheets are then kiln-dried in a specially designed and developed kiln, with a drying practice said to be a sequel to the last word in kiln-drying. Subsequently, the sheets are coated with a phenolic-resin adhesive, electrically heated and pressed at proper temperatures and delivered as finished lumber. These boards meet predetermined specifications, with widths previously unavailable, and with a uniform adherence to specification comparable to that of the steel-construction industry.

If it is desired, a synthetic-resin surface finish may be put on as the last step in the straight-line mass-production routine. The synthetic-resin glue employed in the process is composed of phenol and formaldehyde; the public is familiar with the merits of this resin under the name of Bakelite. Such a glue gives off a vapor which impregnates the wood with phenol and formaldehyde and makes it obnoxious to fungi, and so creates a fungus-proof panel. It is claimed that since the resin is also waterproof the sheets of wood remain firmly bonded under all weather conditions for an indefinite period of time.

Initially, Southern woods—the various gumwoods and Southern pine—will be the principal raw materials. Eventually the vast untouched stores of tropical lumber may be tapped, sources previously uneconomic because of the great number of species and their infinite variety of strength, weight, hardness, and color. They may now be lumbered without selection, compounded to average their weight and strength and surfaced with attractive light-colored selected woods.

The housing and special-product possibilities of "lumber to specification" need little imagination. Furniture and railroad cars and automobile bodies suggest themselves as early users of the new raw materials. The effect on residential construction might be of considerable significance.

Labor's Attitude Toward Time and Motion Study

(*Continued from page 294*)

have given evidence of their responsibility in the conduct of the various phases of industrial relationships. They have in most cases won the confidence and respect of employers; they are respected because they are strong, because they have learned to use their power in the public interest.

Finally, it must be remembered that the labor movement accepts the spiritual side of man; it is the primary basis of its claim. It rejects the commodity theory of labor as a definitely antilabor doctrine. When in 1911, Frederick W. Taylor published his "Principles of Scientific Management," he wrote these words in the introduction: "In the past man has been first; in the future the system must be first." The fallacy of this position has been proved again and again in the last 25 years. Man is always before either his profession or the system. The moral claim of the man is paramount. Industry was made for man, not man for industry.

There can be no question as to the superiority of scientific time study as a measuring device over any less accurate method of time measurement. As the piecework system of wage payment in some form is likely to be with us for some time to come, it is obviously better that piecework rates be based equitably on data accumulated by time study with ample allowance for fatigue than that workers be exposed, as in the past, to the hazard of such rates based on the unscientific opinion or "guess" of a foreman or other member of the supervisory organization. General acceptance of time study by labor, however, will be won only on the basis of frank conference between management and union, in which the method to be used and its objectives are discussed beforehand and labor's consent and cooperation invited. This is the method which was pursued successfully in each of the cases referred to earlier in this paper. Under such a method of union-management cooperation, the unions will know that their members are safeguarded against harmful speeding up and excessive effort, are given an opportunity to participate intelligently in the improvement of their own jobs, have a protected contractual wage scale, and will share equitably in any savings that follow the use of time study. With these prerequisites accepted by management and with more enlightenment on labor's part as to the actual usefulness of time study in eliminating waste and increasing production, increased acceptance of time study by labor doubtless will follow. But what is more, provisions for it will be incorporated as important articles in the collective agreements of the future.

What, in a word, labor seeks in the conduct of American industry is not only a management that is informed by the spirit of science but also one that is dedicated to the ends of justice.

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Water-Cooled Underfeed Stokers

To the Editor:

I have read with considerable interest the paper by Mr. Bennett,[1] describing the progress that has been made in the last five years in developing the water-cooled multiple-retort underfeed stoker. His previous paper[2] excited my interest to the extent that I went out to Cedar Rapids, Iowa, to observe personally the results being obtained when using the Illinois coal of the size and quality mentioned in this paper. I was astonished at the success achieved in burning 1900-deg fusion slack at rates of 55 lb per sq ft of grate and higher.

Since my connection with the coal business over ten years ago was really caused by my failure to keep an industrial plant, of which I was chief engineer, operating because our 12-retort stokers would not carry the load on 2000-deg fusion run of mine, I was particularly interested in this utilization of low-fusion slack.

In my previous connection, coal of this character was purchased without my knowledge and without proper information on equipment by the coal producer. This error in judgment on proper coal application and selection cost the consumer several thousand dollars in maintenance and cost the producer the coal business. As a result, I secured an engineering job with the coal company to build up a service organization in order to minimize such mistakes in the future.

High maintenance with these low-fusion coals and low burning rates have limited the use of underfeed stokers in districts where lower-grade coals were the most economical on a British thermal unit input basis, and, now that the excellent operating results and low maintenance of these water-cooled stokers are being verified in many plants of the Central West, I am sure that wide acceptance of this type of unit in the East will result.

Utilization of low-fusion eastern bituminous coals on the underfeed stoker will now be a question of British thermal unit value and not of a low price that will justify the consumer in tolerating the inconvenience of clinker troubles and excessive maintenance. With this type of unit, the consumer will have unlimited coal selection because the engineers developing this water-cooled stoker have actually accomplished the objective of every combustion-equipment manufacturer, "This unit will burn *anything* that is combustible."

Fixed prices have now been established by the National Bituminous Coal Commission which are higher than the industrial consumer is accustomed to paying. Many coal users with "prima-donna" combustion equipment will now find that the limited group of coals which they have been required to buy are priced on a basis that includes a premium for high quality and foolproof performance characteristics. There will be moaning and gnashing of teeth, but the producer's price is fixed and no chiseling will be permitted.

These new water-cooled stoker units will surely bring much joy to purchasing agents and the operating crews in the boiler room, as well as pay handsome dividends in savings to their owners. The Philadelphia installation shown by Mr. Bennett has been made by one of our customers who formerly required a high-fusion, low-volatile, premium coal. This customer received our encouragement to install this type of unit, and we cooperated closely with the equipment manufacturer to make an installation that would be capable of burning economically the best British thermal unit value in fuel that will be available in the Philadelphia market for the next 20 years. This installation is about ready to start and we have begun shipment on a 20-car order of a high-volatile, low-fusion coal that will effect a substantial saving in steam cost to this industrial user.

I believe that the monopoly of the pulverized-fuel slagging furnace and the chain grate in the utilization of low-fusion and economical low-grade coals has now been broken.

E. C. Payne.[3]

To the Editor:

Both northern and southern Illinois coals have been successfully burned on one of the most recent installations of a water-cooled stoker in the municipal plant at Austin, Minn., and the management expects to experiment further with low-grade coals available in this field. Performance of water-cooled stokers burning various kinds of coal will no doubt be fully commented on by competent observers, and this discussion will, therefore, be confined to a description of burning of natural gas over the water-cooled stoker. Texas and Kansas natural gas with a heating value of 1000 Btu per cu ft is available in southern Minnesota at a cost sufficiently small for successful competition with lowest-priced coals.

When the installation of the unit was under consideration, the expectation was that, in the near future, domestic requirements for natural gas would be built up to a point, where the price of gas for steam production would be prohibitive for 6 or 7 months of the year. Therefore, a unit had to be designed which was capable of burning either coal or natural gas, or both and the analysis of the economies proved that the installation of a highly efficient unit was justified.

A water-cooled stoker of the rotary-ash-discharge type having a projected grate area of 236 sq ft and an effective area of 260 sq ft was installed in a sectionally supported insulated steel-cased setting. It is driven by a Hele-Shaw unit and can be slowed down to less than 2 revolutions per hour, feeding approximately 250 lb of coal per hour to the boiler which has 9580 sq ft of heating surface and waterwalls having 1588 sq ft of heating surface. Air at a maximum temperature of 450 F is supplied by a heater which has 11,350 sq ft of heating surface. The steam has a temperature of 750 F, and its pressure is 450 lb gage when

[1] "Water-Cooled Underfeed Stokers," by J. S. Bennett, Mechanical Engineering, January, 1938, pp. 33–36.

[2] "Design and Development of Water-Cooled Underfeed Stoker," by J. S. Bennett and C. J. Herbeck, Mechanical Engineering, December, 1935, pp. 761–765.

[3] Consulting Engineer, Consolidation Coal Company, Inc., New York, N. Y. Mem. A.S.M.E.

it leaves the superheater which has 3690 sq ft of heating surface.

Three combination gas-and-oil burners are located in the rear of the bridgewall. Up to the present, gas has been burned in combination with a small quantity of coal, the ratio of the heat liberated by the two fuels being 9.5 to 1. Results are uniformly satisfactory, and the following is a typical heat balance:

	Btu per lb of fuel	Per cent
Heating value of combined fuel (90.9 per cent of gas and 9.1 per cent of coal by weight)	20758	100.00
Heat absorbed by water and steam in boiler	14338	69.07
Heat absorbed by steam in superheater	2967	14.29
Total heat absorbed in steam-generating unit	17305	83.36
Heat loss due to theoretical dry gases	626	3.02
Heat loss due to moisture in coal, moisture accompanying theoretical air, and water from combustion of hydrogen	2142	10.32
Heat loss due to excess air and infiltration accompanying moisture entering furnace	260	1.25
Heat loss due to unconsumed hydrogen and hydrocarbons, radiation, and unaccounted for	425	2.05

Operation of this nature with one or two burners was continued for several weeks, the combustion control automatically taking care of load changes of from 14,000 to 36,000 lb per hr, equivalent to from 53 to 140 per cent of boiler rating. The expected maximum capacity is approximately 325 per cent of rating. No variation in steam pressure was experienced, proving the complete flexibility of the unit. Some coal was burned so that in the event of an unexpected interruption of the gas supply, operation can be continued with coal.

With completion of the oil stand-by equipment, we hope to operate the unit with gas alone after building over the stoker an ash covering of sufficient thickness to protect the stoker parts that may not be sufficiently cooled by the tuyère tubes. Should it become necessary to change to coal firing, the oil-burning equipment will be used until a sufficient fuel bed has been built up.

JOSEPH V. EDESKUTY.[4]

TO THE EDITOR:

In the furnace at Rochester, Minn., gas-burner registers are hinged on the

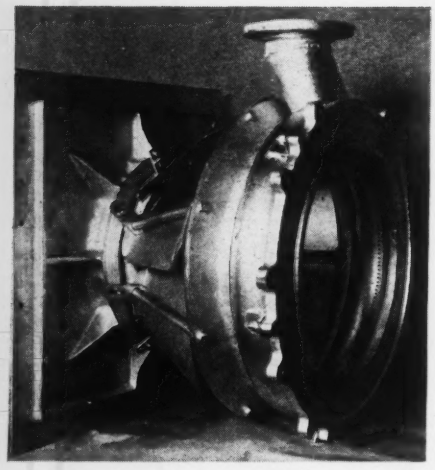


FIG. 1

outer wind-box plate, and the rectangular register fronts are held against this plate by dogs to facilitate swinging out the registers for inserting refractory plugs when it is desired to burn coal for long periods. With the registers hinged in this manner, breaking any gas connections during this operation is not necessary. The burner has the air register mounted on the outer windbox plate, and the gas ring on the saddle is attached to the inner wind-box plate. (See Fig. 1.) Gas is admitted into the burner throat through a series of jets that impinge on and mix with the whirling column of air delivered through the curved air-register doors. The refractory plug can be mounted on a guide pipe so that it can be supported by the hub of the air register in a manner similar to that provided for the diffuser for burning oil. This burner permits using liquid fuel as well as gas, should that be desired.

In a similar installation at Austin, Minn., three burners per boiler were employed and tubes were bent between adjacent burners. In Rochester, four burners per boiler were used and no tubes were bent between adjacent burners.

R. C. VROOM.[5]

TO THE EDITOR:

Mr. Bennett's paper is of particular interest and importance because it presents two major stoker developments; a successful water-cooling system and an extended overfeed section of the stoker which eliminates moving extension grates. These developments were accompanied by other changes, such as the Noblo tuyère, self-cleaning pushers, steeply undercut ashpit wall, and improved grinder teeth. These installations and changes made possible continuous operation of stokers for long periods with low maintenance costs when burning coal with a low ash-fusion temperature. Total stoker-maintenance cost for the Cedar Rapids Plant of the Iowa Electric Light and Power Company is reported at 1.26 cents per ton of coal burned.

Reported maintenance costs are especially low but how much of this can be credited to the water-cooling system is a question. Mr. Bennett states that difficulties were experienced with the operation of the stoker until the design was changed to afford additional cooling for the bottom pushers and coal plates. In doing this, the overfeed section was increased by extending the water-cooling tubes beyond the point where the moving extension grates terminated. They were eliminated and the inner ashpit wall undercut steeply.

Since the operation of these stokers is satisfactory, excessive clinkers are not formed and the pushers can dispose of the ash and clinkers without using the moving extension grates. Design of the ashpit and the crushers with the improved teeth must be satisfactory as the ashpit is maintained even and the ash and clinkers from the lower part of the fuel bed are readily discharged into the pit, a condition that is essential for prevention of operating and maintenance difficulties.

It appears as though extending the overfeed section and eliminating the moving extension grates may be a good design for air-cooled as well as water-cooled stokers. Clinker formations should not exist to any greater extent on air-cooled stokers burning coal with a high ash-fusion temperature than on water-cooled stokers burning coal with a low ash-fusion temperature. Stresses imposed by movement of the fuel bed should be essentially the same in either case, and, therefore, no changes of the pusher-driving mechanism should be required. Since the moving extension grates and the castings immediately above and below them are the parts of the stoker that ordinarily require most-frequent replacements, an extended overfeed-section design, as shown in Mr. Bennett's paper, could well be considered for air-cooled stokers.

Water cooling of the tuyères would undoubtedly be beneficial to stokers burning coal with a high ash-fusion temperature as this would materially reduce the annual tuyère replacement. It is doubtful, however, if this would be a satisfactory solution of tuyère-replacement and continuity-of-service problems in some localities. At the Delray and Conners

[4] Helmick, Edeskuty & Lutz, Engineers, Minneapolis, Minn.

[5] Chief Engineer, Peabody Engineering Corporation, New York, N. Y.

Creek plants of The Detroit Edison Company, coal-feed difficulties are encountered in the winter when the moisture in the coal is 6 or 7 per cent. With this moisture content, the fuel arches in the throat of the ram box or in the coal chute over it and often forms cones of coal on the ram faces which, in turn, adversely affect the rate of coal feed. When operating at normal or high rates of evaporation, lack of coal in the retort, caused by either of these conditions, can readily result in a serious burnout. Water cooling of the tuyères would not necessarily prevent such a condition as it is not uncommon to find the upper pushers and tuyère side plates burned and the tuyères over them intact. Mr. Bennett reports a moisture content of 16 per cent at Cedar Rapids, but apparently no difficulties of this nature are experienced at that plant. Agitators are used to advantage in some plants to prevent the arching of the coal over the rams, but the problem of preventing the building of cones of coal on the ram faces still remains. It would be interesting to know if these conditions occur in any of the water-cooled stokers where the moisture content is high enough to result in hard packing of the coal.

Mr. Bennett reports maximum and maximum continuous hourly coal-burning rates of 56 and 44 lb per sq ft of projected grate area respectively at the Cedar Rapids plant, but the number of hours that coal was burned at these rates is not given. Since maintenance costs are low and the fuel bed is controlled without difficulty on water-cooled stokers, these maximum coal-burning rates apparently could be increased appreciably and maintained for long periods.

Developments in connection with water-cooled stokers have undoubtedly improved operation as well as maintenance. Efficiencies of water-cooled units burning coal of either high or low ash-fusion temperatures are undoubtedly available. It would be interesting, however, to obtain the efficiency and maintenance costs of an air-cooled stoker with an extended overfeed section similar to that on the water-cooled stoker. This may be a favorable development for air-cooled stokers burning coal of high ash-fusion temperature as well as for water-cooled stokers burning coal of low ash-fusion temperature.

F. J. CHATEL.[6]

TO THE EDITOR:

Since October, 1937, a 13-retort water-cooled stoker has been used at the Barberton, Ohio, plant of our Columbia Chemical division in connection with a 900-lb per sq in., 750-F boiler installation having an hourly capacity of 200,000 lb and using preheated air at 300 F. The unit has been operated on Ohio No. 8 nut and slack coal averaging approximately 12,500 Btu per lb with an ash-softening temperature of 2100 F. For the last 35 days of operation, the fuel-burning rate has averaged 45 lb per sq ft per hr, and, for one 24-hr period, the rate was 54.6 lb per sq ft per hr. We expect to operate at continuous ratings at 60 lb per sq ft, which is about the limit of the installed draft capacity. This unit is good for fuel-burning rates that are approximately 30 per cent higher than those of the air-cooled stoker which was installed in 1936.

The unit has not been in service long enough to form definite opinions as to maintenance. However, three older-type 13-retort stokers installed in 1928 have burned 950,000 tons of coal over a nine-year period with a maintenance cost including labor and material of slightly over 5 cents per ton of coal burned. We expect the water-cooled stoker to be materially better than this figure.

Slagging difficulties have been less than on the older units, and it has not been necessary to deslag while in service as yet. This may be due to the greater amount of water-cooled surface and the use of overfire air in the front wall. Maximum heat release is about 32,000 Btu per cu ft and excess air is carried at 35 per cent.

One question that is often asked pertains to abrasion of water-cooling tubes. This did not seem serious to us as we had bare-tube rear walls on two of the older clinker-grinder stokers, and, in nine years service, no tubes have been lost from this cause. To date no signs of wear are apparent on the tubes of the new water-cooled stoker.

R. S. CLARK.[7]

National Apprenticeship

TO THE EDITOR:

Early in his excellent paper[8] on modern apprenticeship and the part being taken in its development by the Federal Committee on Apprentice Training, Mr. Patterson makes this statement: "Various points of view must be gathered up into one controlling point of view, i.e., what is best for the apprentice." This is the crux of the whole matter.

Our experience with unemployment problems in time of depression indicates clearly enough how important it is for the wage worker to acquire some measure of versatility. Unskilled workers and workers with a limited ability in only one field were the first to be laid off and the last to get back. When skilled mechanics did lose their jobs, many of them were able to turn their hands to anything else that offered and thus to keep themselves and their families free of the demoralizing effect of federal political relief. This experience alone is sufficient argument for intensive development of apprentice training in this country. Furthermore, as soon as recovery made appreciable progress, acute local shortages in various skilled trades promptly appeared. Inability to discover keymen slowed down the recovery of many companies and reduced the number of unskilled and semiskilled men that could be employed. This condition bids fair to be greatly intensified when recovery is resumed.

Mr. Patterson quotes one statement in his paper with which I am not sure that I can entirely agree. This is in the third paragraph of the quotation from the House Labor Committee report on the Fitzgerald Bill and reads: "The employer supplies the job and the facilities for training. The workers have the skill and do the actual imparting of skills to the apprentices." Certainly that is not the case in most of the old and highly successful apprentice-training programs in the machinery industry, unless the instructors, usually of the foreman grade, are to be classed as workers. While I would be the last to decry the skill of an experienced journeyman, I submit that it is possible to infer from the statement quoted that the skill of a given trade is a fixed and unchangeable factor to be handed on from father to son, or journeyman to apprentice, ad infinitum. Possibly this may be the case in some trades, but I hate to think so. Most of the trades with which I have any acquaintance are subject to the impact of the engineer and are constantly changing and growing. Sons and apprentices of today must learn far more than their fathers or the journeymen of yesterday knew. By all means let us transmit from journeyman to apprentice all that he has to give, but let us not stop there.

Farther along in the same quotation, however, is this statement which merits hearty endorsement: "The experience of this close cooperation between management and labor on questions of appren-

[6] Assistant Engineer, Delray Plant, The Detroit Edison Company, Detroit, Mich.

[7] Power Engineer, Columbia Chemical Division, Pittsburgh Plate Glass Company, Barberton, Ohio.

[8] "National Apprenticeship," by William F. Patterson, MECHANICAL ENGINEERING, January, 1938, pp. 47–48.

ticeship may be expected to influence beneficially other negotiations between management and labor, with consequent benefits to the whole nation." I would expect that to be the case and Mr. Patterson tells me that he has had exactly that experience in some of his dealings with employers and labor leaders. Let us hope that mutual confidence and respect so developed may spread and deepen rapidly. We need it to offset the class feeling stimulated by such laws as the Wagner Labor Relations Act.

K. H. CONDIT.[9]

Cost Characteristics and Business Policy

TO THE EDITOR:

The review with this title, which appeared in the January issue of MECHANICAL ENGINEERING, is interesting. Although many executives are vitally interested in costs, comparatively few of them view the problem involved in the clear-cut manner that is possible by mathematical analysis. Of course, they intuitively know that profit will be larger by increasing the volume of production and the selling price per unit with lower cost per unit produced and lower fixed cost, which is the expansion into words of the formula $P = NS - F - NV$ stated in the article. However, the other formulas, which represent mathematical juggling of this formula with additions in some cases, are not generally recognized. The writer believes that these formulas, with certain tolerance allowances, can be profitably used by persons directly responsible for manufacturing costs. Curves should be kept showing performance plotted against elapsed time with additions made as soon as the figures are available from cost, sales, and manufacturing departments. Thus, the elevations or dips in the performance of the establishment will be clearly indicated, and corrective steps could be taken when required.

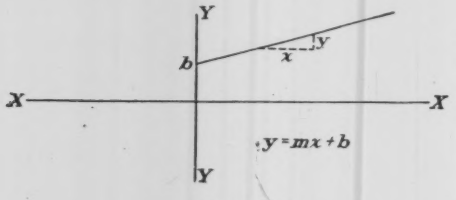


FIG. 2

All costs are a combination of fixed costs, those having no bearing on the volume produced, and variable costs, those directly dependent on the volume produced. Mathematically, this is graphically represented by $y = mx + b$, which is the analytical-geometry formula for the straight line, where y is the total cost of producing x units, b is the fixed cost, and m, which is the slope of the line, represents the variable unit cost or "increment cost" of manufacture, y/x, if the fixed charges were zero. From the accompanying diagram, Fig. 2, the unit cost of production, y/x or $y' = m + b/x$, is derived. It may be too obvious to mention that y' can be kept at the minimum by reducing the values of m and b and increasing the value of x, this last being what is commonly known as "large-scale" production.

JOHN W. HOGG.[10]

CCC Duty Is Engineering Experience

TO THE EDITOR:

The discussion on opportunities afforded engineers, new fields of endeavor, and engineering education, which has been appearing in recent issues of MECHANICAL ENGINEERING, has been of considerable interest to the writer. However, considerable groping and superficial thinking is apparent, with a tendency to dwell on the theoretical and preachment without much apparent effort to get down to details or specific solutions.

In making this statement, we are not overlooking the excellent work that is being done by the Engineers' Council for Professional Development and by the Society for the Promotion of Engineering Education. But we sometimes wonder if the data and information being produced from these two sources are being used to the extent they should? Opinions have been expressed and recommendations made which have been contrary to the findings of both the S.P.E.E. as well as the E.C.P.D.

Obviously, a wide difference of opinion exists between educators and employers. This is especially emphasized in current issues of the bulletin published each week by the Engineering Societies Employment Service. A large number of employers specify minimum and maximum age limits. Others, advertising for juniors, want graduates one or two years out "with experience." Apparently, these employers have no arrangements or facilities for training their own engineers or are willing that someone else bear the expense and trouble.

Again, the Employment Service Bulletin carries a considerable number of advertisements limiting the applicants to graduates of the classes of '35, '36, and '37, or some other combination of recent yearly figures. We can expect to see the elimination of the lowest figure now that we are in the year 1938. When we see advertisements of this order, we wonder what employers have against the graduates during the depression years, the classes of '30, '31, and '32. In some instances, graduates of the classes in depression years are acceptable, providing they have been employed. This, of course, means employment in private enterprise. Employment by the ERA, WPA, NYA, CCC, and other New Deal alphabets is not considered as "employment," or as experience of any value.

Considerable of this can be ascribed to political bigotry and intolerance of the kind that was most ably discussed in the editorial columns of the January, 1938, issue of the *Railway Mechanical Engineer*. In other instances, an honest feeling of doubt exists as to the training and experience values of work for the variety of New Deal organizations. It appears to be a somewhat generally accepted premise that engineers who have gone through this experience are forever ruined for any other line of endeavor.

Much has been said and written relative to the inability of industrialists and businessmen to get along with politicians and government agencies or to understand the peculiar ways of bureaucratic operation. It is also said that "government is in business and in to stay." It is possible as well as probable, that the engineers who have acquired the knowledge and experience of public works and politics during this "recent depression" and "present recession," will be of greater value to private enterprise than those who never had the opportunity for such training. Recognition of this probability appears to be growing, inasmuch as the number of New Deal and major and minor executives being hired by private concerns is increasing. This increase has been considerably more rapid than the increase in general employment during the past year and does not appear to have been materially affected by the present recession.

The idea is false that engineers on relief, or who have been on relief, have lost their spirit, energy, aggressiveness, and what have you. Perhaps they are discouraged at the moment or were discouraged at the time. Losing their jobs was a shock, as might be expected. But

[9] Editor, *American Machinist*, New York, N. Y. Mem. A.S.M.E.

[10] Grasselli Chemical Department, E. I. du Pont de Nemours & Co., Philadelphia, Pa. Mem. A.S.M.E.

let us consider an event of somewhat similar mental strain of recent history.

The World War utilized the time and intense energies of men from 18 years to over 50. The mental stresses and strains which many of them went through during that period cannot be compared to what the depression has had to offer. However, no question arose in 1919 and succeeding years as to their being absorbed by private industry and their ability to render efficient service or to rise in their respective vocations and professions. We had the postwar experiences of the Civil War as a criterion. Veterans of the Civil War rose to high places, and veterans of the World War are important factors in the business and political worlds of today. No fault has been found with their individual work or ability because of their war experiences. True, a few were unable to readjust themselves, and the same can be said for victims of the depression. History makes no record of "adjustment failures" following the depression of the 1890's. Therefore, it must not have been much of a problem, if any. Comparative information relative to "adjustment costs" versus "training costs" might be helpful, at least interesting.

Of the New Deal activities, the Civilian Conservation Corps appears to have earned the approval of both the opponents and friends of the present Administration. A large part of the credit for the success of the CCC belongs to the engineering profession. The work of camp organization and management has been done largely by reserve officers under the general supervision and direction of the regular Army. The large majority of the reserve officers on active duty with the CCC are engineers and rank from captain down to second lieutenant. Reserve officers of field grade, majors and on up, are no longer eligible for CCC duty for reasons of economy.

The average age of the captains on CCC duty appears to be around forty. Practically all of them have held important positions in civilian life. The junior officers, first and second lieutenants, are mostly graduates from college during the depression years and were commissioned from the Reserve Officers' Training Corps, generally known as the R.O.T.C. All of these officers work under U. S. Army regulations and discipline and are subject to the same rigid system of inspection and semiannual reports on their personal efficiency. We know of no concern, company, or corporation that subjects its officers and department heads to anywhere near the equal with respect to what is expected in results and discipline.

Competition is unusually keen. Reserve officers are appointed to active duty with the CCC for periods of six months. Renewal of their appointment depends on their ability to produce. Although the rules of the CCC expressly forbid military training of any description whatsoever, nevertheless, the War Department and those responsible for reserve training consider active duty with the CCC to be good training in leadership, mess management, and supply and camp administration. For that reason, it is desirable to give as many reserve officers as possible training with the CCC. The period that an officer may remain on duty with the CCC is limited from three to four years, depending on the officer's assignment.

Therefore, when an engineer comes to you for a job, tells you that he is a reserve officer and was on active duty with the CCC for several years, you have a live, well-trained, seasoned, experienced man before you. No sympathy or sentiment is wasted in the U. S. Army. No patience is shown with inefficiency. The fact that he has served several six-month periods is more than sufficient evidence that you will be taking no chances in giving him a job. The engineer may have been on relief prior to his appointment to active duty. Many of them have. But whatever effects, if any, may have carried over from that experience, they are no longer factors worth considering. He has graduated with honors from an exacting school of hard knocks.

Engineers, junior officers serving as camp commanders, and executives fully appreciate the position they are in with respect to competition with last year's graduates for jobs in private industry. They know that they are expected to go through the same training as other young engineers just starting out. They know that they must acquire practical knowledge to advance in their profession. They also know that the intensive training in leadership and administration that they have received in the CCC will give them a distinct advantage over the others.

The difficult problem for these young engineers is to develop employer contacts and, at the same time, boss and care for several hundred young men camped in the woods miles from nowhere. Administering to the needs of a CCC camp is a full-time job, with little or no time for anything else. Therefore, they cannot do much toward improving their position, except to wait until their final period of service is about to expire, take a leave of absence, and start hunting for a job.

Those responsible for the military preparedness of the United States expect the CCC-trained reserve officer to bear the larger part of the burden of combat along with the regular Army and the National Guard. Their position will be one of extreme importance in time of national emergency. No doubt exists in the minds of those familar with the Corps and its requirements but that these officers will more than meet expectations. Under such circumstances, the maintenance of a high *esprit* is of extreme importance. The quality of their loyalty and patriotism, and of their willingness to bear more than their share of the responsibilities of American citizenship is not doubted.

This is not a bid for preference. It is only to explain and clear up any questions pertaining to the work and status of reserve officers on duty with the CCC. The CCC is a wonderful field for engineer training. We think that employers of engineering talent are possibly overlooking a good bet, because of misunderstanding as well as misinformation.

The reserve officer has already met competition and won. He has no fear of another contest. Given a fair chance and an equal start, he is not worrying about the future. All things considered, why should he?

MARION B. RICHARDSON.[11]

Coal Selection for Steam-Generating Equipment

TO THE EDITOR:

The basis for my discussion of Mr. Sherman's excellent and stimulating paper[12] is to be found in three of his sentences, as follows:

> Many of our present analytical tests for the characteristics of coal have been standardized for over 20 years. . . . The American Society for Testing Materials has 12 Standards and 4 Tentative Standards on Methods of Testing Coal. . . . Despite their constant use, some uncertainty arises from time to time as to the significance of the results of the tests.

This situation arises naturally from lack of knowledge of the physical and chemical conditions prevailing during combustion of coal and how these conditions change with control of measurable variables. In this circumstance, any test, even if standardized for 20 years, is an empirical one in which all significant variables may not be controlled or, if

[11] Educational Adviser, Civilian Conservation Corps' Headquarters, 2nd Corps Area, Governors Island, N. Y. Mem. A.S.M.E.

[12] "Status of Our Knowledge of Coal Selection for Steam-Generating Equipment," by R. A. Sherman, MECHANICAL ENGINEERING, November, 1937, pp. 829–834.

controlled, may be given values wholly different from those that would be chosen with a better understanding of the process. As an illustration, using the data of Nicholls in a Bureau of Mines Bulletin,[13] the correlation coefficient between "clinker over 2 in." and "ash-softening temperature" is 0.74, and that between "clinker over 1/2 in." and "ash-softening temperature" is 0.73. These values are high enough to indicate that a relationship certainly exists between clinker formation and softening temperature, but even so it should not be concluded that an accurate estimate of one can be made from a knowledge of the other. In fact, after taking into account the linear relation between clinker formation and softening temperature, the standard deviation of the quantity of clinker is 67 per cent of what it was originally, that is, 67 per cent of our lack of knowledge remains.

More significant tests for determining the suitability of a coal for combustion can result only either by luck or by much work on studies of fuel beds. Supplementing the work of Nicholls and others, the work of Bituminous Coal Research, Inc. at Battelle Memorial Institute on small stokers and that on large stokers, in cooperation with the coal research laboratory of the Carnegie Institute of Technology and with the Consolidated Edison Company, should lead to modifications of existing tests and probably suggest tests that are different from any now used. In this way, ultimately, selection of coal for steam-generating equipment should be placed on a sound scientific basis.

Mr. Sherman has pointed out the need for a method of measuring the coking characteristics of coals. You may be interested in a method, developed in Russia by Sapozhnikov with some theoretical justification and extensively used; in fact, the equivalent of approximately $250,000 per year is being spent to characterize Russian coals by this method. The test determines maximum thickness of the plastic layer and total shrinkage under pressure on heating a sample of coal to about 1650 F. When the values obtained for different coals are plotted, those coals suitable for coke-making in by-product ovens are grouped in a relatively small area. A small zone separates coals which on heating give a pervious plastic mass having a resistance to air flow of less than 1 atm and those which yield a highly impervious plastic mass having a resistance to air flow of over 50 atm. Use of this Sapozhnikov method for characterizing coals for combustion would be highly empirical; much additional work both on the test and on determination of conditions in fuel beds would be needed before its significance became clear.

I should like to second Mr. Sherman's answer to the coal-selection problem—research and education. I wish, however, to emphasize that the educational efforts should not be limited to disseminating existing knowledge but that attention should be drawn to those aspects of the problem where knowledge is partially or completely lacking. This latter should lead to wider recognition of the need for research and possibly correct false conceptions of the problem.

H. H. LOWRY.[14]

[13] "Clinker Formation as Related to the Fusibility of Coal Ash," by P. Nicholls and W. A. Selvig, U. S. Bureau of Mines Bulletin No. 364, 1932.

[14] Director, Coal Research Laboratory, Carnegie Institute of Technology, Pittsburgh, Pa.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of January 14, 1938, which were subsequently approved by the Council.

CASE No. 820

(Annulled)

CASE No. 846

(Annulled)

CASE No. 854

(*Special Ruling*)

Inquiry: Will boilers and pressure vessels meet code requirements if fabricated of alloy steel plate material complying with Specification S-28?

Reply: It is the opinion of the committee that alloy steel plate having the physical properties specified in and otherwise conforming to Specification S-28, Grade A, may be used in the welded construction of boilers and pressure vessels provided the provisions of Pars. P-101 to P-111, or Par. U-68 are complied with.

Revisions and Addenda to Boiler Construction Code

IT IS THE policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place in the code.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from any one interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

PAR. P-26*b*. Proposed revision appearing in June, 1937, issue cancelled.

PARS. P-195*e* AND U-36*e*. Revised to read:

e Where the radius *L* to which the head is dished is less than 80 per cent of the diameter

of the shell, the thickness of a head with a FLANGED-IN manhole opening shall be at least that found by making L equal to 80 per cent of the diameter of the shell AND WITH THE ADDED THICKNESS FOR THE MANHOLE. This thickness shall be the minimum thickness of a head with a FLANGED-IN manhole opening for any form of head.

PAR. P-269*b*. Replace revision appearing in June, 1937, issue by the following:

b Safety valves may have bronze parts complying with either Specifications S-41 or S-46 (A.S.T.M. B62-36), provided the maximum allowable working stresses and temperatures do not exceed the values given in Table P-8 and shall be marked to indicate the class of material used. Such valves shall not be used on superheaters delivering steam at a temperature over 450 F and 306 F, respectively.

PAR. P-299*j*. Replace revision appearing in June, 1937, issue by the following:

j Bronze fittings or valves may be made of material complying with either Specifications S-41 or S-46 (A.S.T.M. B62-36), provided the maximum allowable working stresses and temperatures do not exceed the values given in Table P-8 and shall be marked to indicate the class of material used.

Specification S-26. The title, Pars. 1 and 3 to be revised to make them identical with A.S.T.M. Specifications A 149–36.

Specification S-27. The title, Pars. 1, 3*b* and 4 to be revised to make them identical with A.S.T.M. Specifications A 150–36.

Specification S-34. To be replaced by A.S.T.M. Specifications A 158–37T.

Specification S-42. To be identical with A.S.T.M. Specifications A 201–37T for Carbon-Silicon-Steel Plates of Ordinary Tensile Ranges for Fusion-Welded Boilers and Other Pressure Vessels.

Specification S-43. To be identical with A.S.T.M. Specifications A 203–37T for Low-Carbon-Nickel Steel Plates for Boilers and Other Pressure Vessels.

Specification S-44. To be identical with A.S.T.M. Specification A 204–37T for Molybdenum-Steel Plates for Boilers and Other Pressure Vessels.

Specification S-45. To be identical with A.S.T.M. Specification A 206–37T for Seamless Carbon-Molybdenum Alloy-Steel Pipe for Service at Temperatures from 750 to 1000 F.

Specification S-46. To be identical with A.S.T.M. Specifications B62-36 for Composition Brass or Ounce Metal Castings.

Specification S-47. To be identical with A.S.T.M. Specifications B111–37T, and to replace present Specifications S-29, S-30, and S-31.

PAR. H-80. Insert the following new rule:

H-80 Unstayed dished heads, either concave or convex to pressure, with or without flanges, may be used in steam heating boilers, and hot-water boilers or hot-water supply boilers for pressures not in excess of 30 lb per sq in., provided the diameter of the heads does not exceed 42 in. and the radius of dish does not exceed 75 in.

For higher pressures and greater diameters, dished heads must have flanges not less than 1 in. in length and shall be designed in accordance with the rules in the Power Boiler Code.

Table P-8. (Old Table P-7½) Revised:

TABLE P-8 MAXIMUM ALLOWABLE WORKING STRESSES FOR NON-FERROUS MATERIALS IN LB PER SQ IN.

Material	Spec. number	For temperatures not exceeding deg F: 70 to 100	150	250	350	406	450	500	550
Muntz metal tubing and high brass tubing	S-24	5000	5000	4000	2500	...	...	...	...
Muntz metal condenser tubes	S-30	5000	5000	4000	2500	...	...	...	...
Red brass tubes	S-24	6000	6000	5500	5000	4500	...	...	...
Copper tubes	S-22	6000	6000	5000	4500	4000	...	...	...
Copper pipes	S-23	6000	6000	5000	4500	4000	...	...	...
Brass 70–30 condenser tubes	S-29	6000	6000	5000	4500	4000	...	...	...
Admiralty tubing	S-24	7000	7000	6500	6000	5500	4500	...	...
Admiralty condenser tubes	S-31	7000	7000	6500	6000	5500	4500	...	...
Steam bronze	S-41	6800	6800	6300	5800	5400	5000	4200	3300
Steam bronze	S-46[1]	5500	5500	5000	4500	3500	...	...	...

[1] A.S.T.M. Specifications B62-36.

Table U-4. Revised:

TABLE U-4 MAXIMUM ALLOWABLE WORKING STRESSES FOR NON-FERROUS MATERIALS IN LB PER SQ IN.

Material	Spec. number	For temperatures not exceeding deg F: Sub zero	70 to 100	150	250	350	406	450	500	550
Muntz metal tubing and high brass tubing	S-24	5000	5000	5000	4000	2500	...	...	...	...
Muntz metal condenser tubes	S-30	5000	5000	5000	4000	2500	...	...	...	...
Red brass tubes	S-24	6000	6000	6000	5500	5000	4500	...	...	...
Copper plates	S-20	6000	6000	6000	5000	4500	4000	...	...	...
Copper tubes	S-22	6000	6000	6000	5000	4500	4000	...	...	...
Copper pipe	S-23	6000	6000	6000	5000	4500	4000	...	...	...
Brass 70–30 condenser tubes	S-29	6000	6000	6000	5000	4500	4000	...	...	...
Admiralty tubes	S-24	7000	7000	7000	6500	6000	5500	4500	...	...
Admiralty condenser tubes	S-31	7000	7000	7000	6500	6000	5500	4500	...	...
Copper-silicon alloy plates, rods, bars, and shapes	S-36 / S-37[1]	10000	10000	10000	10000	...	...	...	...	...
Monel	(2)[2]	14000	14000	14000	14000	14000	14000	13500	13000	12500
Steam bronze	S-41	6800	6800	6800	6300	5800	5400	5000	4200	3300
Steam bronze	S-46[3]	5500	5500	5500	5000	4500	3500	...	...	...
Cupro nickel	S-47[4]	10000	10000	10000	10000	9000	8400	7500	6300	5000

[1] Type A and C only.
[2] Applies to 70,000 lb tensile strength rolled and annealed material.
[3] A.S.T.M. Specification B62-36.
[4] A.S.T.M. Specification B111–37T 70–30 Copper-Nickel and 80–20 Copper-Nickel Type A and B only.

PAR. U-13. Replace revision appearing in May, 1937, issue by the following:

b Nonferrous plates may be used in the construction of unfired pressure vessels when specifications are given in Section II of the code and stresses as provided in Par. U-20 are followed.

PAR. U-20. Replace revision appearing in May, 1937, issue by the following:

e Nonferrous Plates. Maximum allowable working stresses for nonferrous materials conforming to specifications in Section II of the code shall not exceed the values given in Table U-4 for metal temperatures shown.

Add the following as (*f*):

f Bronze fittings or valves may be made of material complying with either Specifications S-41 or S-46 (A.S.T.M. B62-36) provided the maximum allowable working stresses and temperatures do not exceed the values given in Table U-4, and shall be marked to indicate the class of material used.

PAR. U-120. Revise first sentence to read:

The rules for this class of vessels shall apply . . . when constructed of steel complying with Specifications S-1 . . ., or S-27 for High Tensile Strength Carbon-Steel Plates for Fusion-Welded Pressure Vessels . . ., OR OF CAST STEEL COMPLYING WITH SPECIFICATION S-11, CLASS B, and when operated at pressures, etc.

Books Received in Library

ADVANCED CALCULUS. By W. B. Fite. The Macmillan Co., New York, 1938. Cloth, 6 × 9 in., 399 pp., diagrams, tables, $5. The student who intends to specialize in mathematics will find here "an introductory course in mathematical analysis." Assuming familiarity with the basic operations of the calculus, the book discusses functions of more than one variable, indefinite, infinite and multiple integrals, various types of series, and applications to geometry. The calculus of variations and functions of a complex variable are treated briefly.

AIR CONDITIONING IN SUMMER AND WINTER. By R. E. Holmes. McGraw-Hill Book Co., New York and London, 1938. Cloth, 6 × 9 in., 296 pp., illus., diagrams, charts, tables, $3. An elementary, comprehensive treatment of the science of air conditioning. Intended for those who wish to do work in that field, the book presents such information as will give an understanding of the practical problems of designing and installing air-conditioning apparatus for both summer and winter conditions, and of the principles and methods by which these problems are worked out.

ATM (Archiv für Technisches Messen), Lieferungen 75–77, September, 1937–November, 1937. R. Oldenbourg, Munich and Berlin. Paper, 8 × 12 in., illus., diagrams, charts, tables, 1.50 rm each. Three numbers of a monthly publication containing classified articles covering various types of apparatus and methods for technical measurements. Certain ones also contain descriptions of specific instruments manufactured by German companies.

BÉTON ARMÉ, by V. Forestier. Eleventh edition, 324 pp.; CONSTRUCTION MÉCANIQUE, by J. Izart. Fifty-seventh edition, 336 pp.; ÉLECTRICITÉ, by L. D. Fourcault. Fifty-seventh edition, 383 pp.; MÉTALLURGIE, by R. Cazaud. Fifty-fourth edition, 328 pp.; MINES, by E. Stalinsky. Fifty-seventh edition, 305 pp.; PHYSIQUE INDUSTRIELLE, by J. Izart. Eighteenth edition, 379 pp. (Agendas Dunod) Dunod, Paris, 1938. Leather, 4 × 6 in., diagrams, charts, tables, 25 fr each. A series of six small technical pocketbooks. The respective subjects treated are: reinforced concrete; industrial physics; machine design and mechanisms; electricity; metallurgy; and mining. A section of general tables of mathematical functions, units, weights and measures is duplicated in each volume.

DIESEL OPERATORS' GUIDE AND DATA BOOK, 1937–1938 edition. Edited by L. H. Morrison. Diesel Power & Diesel Transportation, New York, 1937. Leather, 9 × 12 in., 304 pp., illus., diagrams, charts, tables; standard edition, $5; de luxe edition, $6. Two types of material comprise this book. The "Data-Service" section, which is intermixed with the advertising pages, contains brief technical descriptions of operations, calculations, or applications of interest to Diesel men, furnished by manufacturers. The middle portion consists of several chapters, each describing in detail a particular type of Diesel engine or piece of special equipment.

DIFFERENTIAL AND INTEGRAL CALCULUS. Two volumes. By R. Courant, translated by E. J. McShane. Revised edition. Nordemann Publishing Co., New York, 1937. Cloth, 6 × 9 in., diagrams, charts, tables. Vol. 1, 616 pp., $5; vol. 2, 682 pp., $7. In this translation from the German a noteworthy feature is the treatment of the differential calculus and the integral calculus simultaneously. The first volume corresponds to a beginning course, presenting a detailed account of the theory of functions of one variable, and including also a sketch of the theory of functions of several variables and certain simple differential equations. Volume II completes the study of functions of several variables and multiple integrals, continues differential equations, and takes up the calculus of variations and complex variables. Appendixes to each chapter are for supplementary study. Many problems with answers are given.

DYKE'S AUTOMOBILE AND GASOLINE ENGINE ENCYCLOPEDIA. By A. L. Dyke. Eighteenth edition. Goodheart-Willcox Co., Chicago, 1937. Cloth, 7 × 10 in., 1242 pp., illus., diagrams, charts, tables, $6. A remarkably comprehensive collection of information on automobiles and gasoline engines for the use of students, repairmen, and owners. Principles, description, and operation of all mechanical, propulsive, and electrical parts of an automobile; maintenance, testing and repair; specifications and definitions; these and other subjects are covered. Many illustrations and an eighty-page index increase the utility of the book.

ELEKTROWÄRMETAGUNG. Berlin, June 5, 1936, im Marmorsaal des Zoologischen Gartens, veranstaltet von der Wirtschaftsgruppe Elektrizitätsversorgung und Wirtschaftsgruppe Elektroindustrie. Arbeitsgemeinschaft zur Förderung der Elektrowirtschaft, Berlin, 1937. Paper, 8 × 12 in., 100 pp., illus., diagrams, charts, tables. A collection of papers presented at a joint meeting of the Wirtschaftsgruppe Elektrizitätsversorgung and the Wirtschaftsgruppe Elektroindustrie, on various matters connected with electric furnaces. The industrial importance of electric heating and recent development in arc, induction, and resistance furnaces are discussed.

DIE ENERGIEWIRTSCHAFT DER WELT, edited by C. Krecke. V.D.I. Verlag, Berlin, 1937. Cloth, 6 × 10 in., 193 pp., diagrams, charts, tables, 10 rm. This volume is intended to give German engineers a summary of the reports presented by speakers from other countries at the Third World Power Conference, Washington, 1936. The book opens with a translation of President Roosevelt's address before the Conference. This is followed by reviews of the reports upon statistics, fuels, electricity, gas, and water, and upon national power resources as a whole.

ENGINEERING LAW. By R. E. Laidlaw and C. R. Young. University of Toronto Press, Toronto, 1937. Cloth, 6 × 9 in., 380 pp., tables, $4. A presentation of those phases of law that impinge in some manner on the acts, duties, and liabilities of the engineer. Not intended as a legal text, this book gives salient facts concerning contracts, specifications, industrial disputes, patents, company organization, and questions in connection with boundaries, surveys, and other technical matters. The authors are Canadian authorities, and the references are to Canadian and English law reports.

FLOUR MILLING TECHNOLOGY. Two volumes. 1935–1936 and 1936–1937. By L. Smith. Thomas Robinson & Son, Ltd., Rochdale, England, 1937. Cardboard, 6 × 10 in., vol. 1, 270 pp.; vol. 2, 231 pp., diagrams, charts, tables, 3s 6d each volume. These volumes contain a practical course in flour milling, intended for home study, which is sponsored by the Technical Education committee of the National Industrial Council for the Flour Milling Industry of Great Britain. A detailed description of milling machinery and operations is provided, and the principles of milling processes are explained. The books are profusely illustrated by drawings.

FUNDAMENTALS OF MACHINE DESIGN. By C. A. Norman, E. S. Ault, and I. F. Zarobsky. The Macmillan Co., New York, 1938. Leather, 6 × 9 in., 486 pp., diagrams, charts, tables, $4.25. The basic principles underlying machine design are illustrated by typical problems. Not only is the application of these fundamentals to the design of machine elements discussed, but also the application of the elements in composite machinery and the influence on the design of related members. A wide variety of mechanisms is considered, and chapters are included on the selection and strength of engineering materials.

HYDRO- AND AERO-DYNAMICS. By S. L. Green. Sir Isaac Pitman & Sons, Ltd., London; Pitman Publishing Corporation, New York, 1937. Cloth, 6 × 9 in., 166 pp., diagrams, charts, tables, $3.50. An introduction to the theory of the motion of fluids, including modern developments, for students of aeronautics and physics. Subjects covered include continuous and discontinuous motion in two dimensions, vortex motion, wave motion, and motion of a viscous fluid.

INDUSTRIELLE ELEKTROWÄRME, edited by Wirtschaftsgruppe Elektrizitätsversorgung. Teil 2: GRUNDFRAGEN DER ELEKTROWÄRMETECHNIK, by K. Mertens. Droste Verlag und Druckerei, Düsseldorf, 1937. Paper, 6 × 8 in., 62 pp., diagrams, charts, tables, 1 rm. This pamphlet contains practical examples of basic calculations in heat content, conduction, loss, radiation, and accumulation. Other subjects discussed include materials for electric heating apparatus, economy of electricity as compared with gas for heating purposes, and temperature measurement and regulation.

INDUSTRIELLE ELEKTROWÄRME, edited by Wirtschaftsgruppe Elektrizitätsversorgung. Teil 3: WO WIRD ELEKTROWÄRME MIT VORTEIL ANGEWENDET? Arbeitsgemeinschaft zur Förderung der Elektrowirtschaft, Berlin, 1937. Paper, 6 × 8 in., 116 pp., illus., 1 rm. A presentation, in tabular form, of the electric heating processes and equipment which may be used advantageously in various industries. An ingenious system of cross references allows a great deal of information to be given in a relatively small space.

INDUSTRIELLES RECHNUNGSWESEN. Two parts, edited by Ausschuss für industrielles Rechnungswesen (AFIR) des Vereines deutscher Ingenieure. Second edition. V.D.I. Verlag, Berlin, 1937. Paper, 8 × 12 in., diagrams, charts, tables. Teil I: Grundlagen, by H. Funke. 70 pp., 12 rm. Teil II: Anwendungen, edited by O. Schulz-Mehrin

and F. Zeidler. 72 pp., 9.50 rm. A publication of the V.D.I. Industrial accounting committee. Part I covers basic considerations of accounting and balances, budgets, operating statistics and adjustments, cost and profit calculations, etc. Part II shows the application of these principles in profit, expense, valuation, price, write-off, interest, and other calculations. Both texts are supplemented by a group of loose tables and charts.

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS, LONDON CONGRESS, April 19–24, 1937. London, International Association for Testing Materials, 28 Victoria St., London, S.W.1, 1937. Cloth, 7 × 11 in., 661 pp., illus., diagrams, charts, tables, 30 s. This volume contains the proceedings and papers of the London Congress. The topics discussed were: The effect of temperature upon the mechanical and chemical behavior of metals; the progress of metallography; light metals and their alloys; workability and wear of metals; concrete and reinforced concrete; natural stone; ceramic materials; textiles; wood cellulose; timber preservation; aging of organic materials; colors and varnishes; the relation between the results of laboratory tests and behavior in use and service; the bearing of recent advances in physics and chemistry on the knowledge of materials; the properties of materials for the thermal and acoustic insulation of buildings.

LIGHT, PHOTOMETRY, AND ILLUMINATING ENGINEERING. By W. E. Barrows. New York and London, McGraw-Hill Book Co., 1938. Cloth, 6 × 9 in., 445 pp., illus., diagrams, charts, tables, $4. An extensively revised edition of a textbook on illumination principles and practice. The fundamentals remain essentially the same, but the chapters on light sources, illumination calculations, and interior and street lighting have been altered where necessary, and new chapters on gas and vapor lamps, lighting for recreations and sports, and the lighting of highways and airways have been added.

LIGHT, Principles and Experiments. By G. S. Monk. McGraw-Hill Book Co., New York and London, 1937. Cloth, 6 × 9 in., 477 pp., illus., diagrams, charts, tables, $5. Textbook and laboratory manual for the advanced study of geometrical optics, classical physical optics, and the more recent extensions of physical optics which deal with the origin of spectra, the interaction of light and material media, and the effects on that interaction of external electric and magnetic fields. The general subject of color and its measurement is covered, including a noteworthy discussion of recent progress in colorimetry.

LOW TEMPERATURE PHYSICS. By M. and B. Ruhemann. University Press, Cambridge, England; The Macmillan Co., New York, 1937. Cloth, 5 × 9 in., 313 pp., diagrams, charts, tables, $5. This book discusses the principal problems that have occupied low-temperature physicists since the subject became a separate branch of study. The account follows historical sequence to some extent, proceeding from such large phenomena as condensation and fusion to processes intimately connected with elementary particles and the fundamental structure of matter. Special attention is given for practical reasons, to the principles of gas liquefaction and rectification. The book is intended for physicists specializing in other fields, whose interest is also in low-temperature work, and for students, rather than for the expert. There is a bibliography.

MAGNESIUM AND ITS ALLOYS. By J. L. Haughton and W. E. Prytherch. Great Britain, Department of Scientific and Industrial Research. His Majesty's Stationery Office, London, 1937. Cardboard, 6 × 10 in., 100 pp., illus., diagrams, charts, tables (obtainable from British Library of Information, 270 Madison Ave., New York, $0.80). This monograph, which is based upon the investigations carried out during the past five years at the National Physical Laboratory of Great Britain, summarizes the existing information about magnesium and its important alloys. The production and properties of magnesium, methods of melting, and casting are considered. The behavior of the metal and its alloys under plastic deformation is explained, and the methods of rolling, forging, heat-treatment, etc., are described. Considerable attention is paid to the mechanical properties at room and at high temperature. The constitution of the alloys is discussed. There are a bibliography and a collection of equilibrium diagrams.

A MANUAL OF PHYSICAL MEASUREMENTS. By A. Zeleny and H. A. Erikson. Sixth edition. McGraw-Hill Book Co., New York and London, 1937. Cloth, 6 × 8 in., 273 pp., diagrams, charts, tables, $2.25. An outline of laboratory experiments for university courses in general physics. Completeness is not attempted either in subject matter or explanation; additional information is to be furnished by the instructor. The customary fields of mechanics, fluids, heat, sound, light, electricity and magnetism are included.

OIL HEATING HANDBOOK. By H. A. Kunitz. Second edition, revised. J. B. Lippincott Co., Philadelphia and London, 1937. Cloth, 5 × 8 in., 464 pp., illus., diagrams, charts, tables, $3.50. Intended as a guide for those who design, install, sell, or use oil-heating equipment. Following an introductory chapter describing the oil-burner system in general are sections on fuels and combustion, heating and heating systems, control mechanisms, installation, and service work; and also retail-selling information. Part 6 is devoted to forms, tables, statistics, and terminology.

PRINCIPLES OF POWDER METALLURGY. By W. D. Jones. Longmans, Green & Co., New York; Edward Arnold & Co., London, 1937. Cloth, 6 × 9 in., 199 pp., illus., diagrams, charts, tables, $5. The first complete presentation in English of the use of metal powders for forming solid articles by means of pressure and heat. In addition to the principles of sintering, the physical properties of sintered-metal compacts, and their industrial applications, the book also treats adequately the manufacture, properties, and testing of metal powders.

PROTECTIVE FILMS ON METALS. By E. S. Hedges. Second edition, revised. D. Van Nostrand Co., New York, 1937. Cloth, 6 × 9 in., 397 pp., illus., diagrams, charts, tables, $6. A practical book on corrosion and its prevention. It divides naturally into two parts: Chapters 1 to 6 cover the mechanism of corrosion and theoretical discussions of film formation; chapters 7 to 12 take up the practical applications of oxide and similar films, hot-dip coatings, electroplating, sprayed metal films, and cementation. Chapter 13 contains a brief discussion of paints, lacquers, and enamels, especially as applied to metallic surfaces.

SHEET METAL WORK. By W. Neubecker. American Technical Society, Chicago, 1938. Cloth, 6 × 9 in., 360 pp., illus., diagrams, charts, tables, $2.50. Practical explanations of all types of sheet-metal work, fully illustrated with diagrams and layouts. While fundamental principles are stressed and explanations are detailed for the use of the beginner, there is also much specific material of value to the experienced metal worker. Useful tables of data are included.

TECHNICAL MATHEMATICS, 3 Vols. By H. M. Keal and C. J. Leonard. Second edition. John Wiley & Sons, New York and London, 1938. Cloth, 5 × 7 in., vol. 1, 246 pp.; vol. 2, 277 pp.; vol. 3, 314 pp.; illus., diagrams, charts, tables, $1.25 each volume. The three volumes of this secondary or trade-school textbook treat respectively the subjects of algebra, geometry, and trigonometry. The object is to provide a sound basis for future technical education as well as for actual shop, laboratory, or drawing-room work. The third volume contains also illustrative practical problems and a section on the use of the slide rule.

LA TRACTION ÉLECTRIQUE ET LE CHEMIN DE FER. (Vol. 1. Cinématique et Dynamique de l'Exploitation des Chemins de Fer). By H. Parodi, A. Tétrel, and P. Richemond. Dunod, Paris, 1935. Bound and paper, 7 × 10 in., 559 pp., diagrams, charts, tables; paper, 148 fr.; bound, 158 fr. The first volume of a comprehensive work on railway electrification, in which special attention is given to the problems which accompany the use of electric power and the new methods of railway operation that become possible. Volume one discusses the kinematics and dynamics of operation. Train equipment, track maintenance, stations, line capacity, axle loads, adhesion, train resistance, brakes, etc., are considered.

[a]V.D.I.-FORSCHUNGSHEFT 387. MESSUNG DER GESAMTSTRAHLUNG VON WASSERDAMPF UND KOHLENSÄURE IN MISCHUNG MIT NICHTSTRAHLENDEN GASEN BEI TEMPERATUREN BIS ZU 1300 C, by E. Eckert. V.D.I. Verlag, Berlin, 1937. Paper, 8 × 12 in., 20 pp., illus., diagrams, charts, tables, 5 rm. In this new study of the total radiation of steam and carbon dioxide, the measurements were not made upon pure gases, but upon mixtures with nitrogen. The report shows that the usual method of calculating the radiation leads to large errors. The results of the study are presented in a form that enables the radiation in any case that occurs in practice to be obtained from a steam-carbon dioxide diagram.

Die WÄLZLAGER. By W. Jürgensmeyer. Julius Springer, Berlin, 1937. Cloth, 8 × 11 in., 498 pp., illus, diagrams, charts, tables, 48 rm. A comprehensive treatise on ball and roller bearings. A full treatment of the history of bearing development precedes a section on modern bearing science which covers types and sizes of bearings, friction, bearing power, and the life of bearings. The next section covers bearing design, placing, lubrication, and packing. Then follow fitting and finishing procedures, care and maintenance of bearings, standards and the status of standardization, and test methods. A very useful section includes a classified index to illustrations, lists of symbols, a bibliography, and a list of manufacturers in various countries. A pocket contains tables of standard and actual dimensions and bearing values.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

A.S.M.E. Semi-Annual Meeting to Be Held at St. Louis, Mo.

During Week of June 20–24, 1938

THE SELECTION of St. Louis, Mo., for the 1938 A.S.M.E. Semi-Annual Meeting, during the week of June 20, affords every member of the Society an excellent opportunity to visit a center of middle-western activity. Because of its location St. Louis has become a city of diversified industries and the program which is being planned for this meeting will enable those in attendance to visit many types of industrial plants.

St. Louis Section Committees Appointed

The St. Louis Section of the A.S.M.E. has already appointed its committees for the meeting with C. J. Colley, as general chairman. Mr. Colley promises to make this Semi-Annual Meeting "one of the best ever held by the Society."

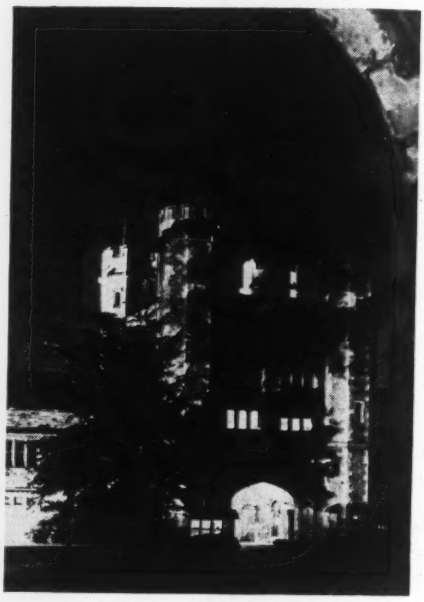
E. H. Tenney, chairman of the technical sessions committee, states that there have been a great number of excellent papers submitted for inclusion in the program and from these it is expected that sessions will be arranged by the Fuels, Power, Process, Management, Materials Handling, Hydraulic, and Railroad Divisions, as well as by the committee on Education and Training for the Industries.

In addition to the papers and inspection trips, St. Louis offers its visitors many other attractions of national repute. The Missouri Botanical Gardens are second only to the famous Kew Gardens of England, while the outdoor municipal opera, which will be open during the time of the meeting, is always an attraction to the music lover. For those who take their pleasures differently, there will be the National and American Leagues baseball games.

Headquarters at Statler

The Hotel Statler, headquarters for the meeting, has been completely air-conditioned, and its arrangements are unusually good for convention purposes.

STATLER HOTEL IN ST. LOUIS, HEADQUARTERS FOR A.S.M.E. SEMI-ANNUAL MEETING



Courtesy St. Louis Convention Bureau

A NIGHT PHOTOGRAPH OF THE TOWER GATEWAY AT THE WASHINGTON UNIVERSITY IN ST. LOUIS, MO.

Actions of A.S.M.E. Executive Committee

AT THE February 19 meeting of the Executive Committee of the Council of The American Society of Mechanical Engineers, several matters of general interest were discussed. Present at the meeting were Harvey N. Davis, chairman; Harte Cooke, James W. Parker, and Kenneth H. Condit, of the committee; K. M. Irwin (Finance), Crosby Field (Professional Divisions), and J. N. Landis (Local Sections), advisory members; and C. E. Davies, secretary.

The death, on February 8, 1938, of Bennett M. Brigman, vice-president of the Society, was noted with deep regret. (See MECHANICAL ENGINEERING, March, 1938, page 249.) The secretary reported that E. A. Muller, of Cincinnati; and L. R. Jackson and J. H. Romann, of Louisville, had served as honorary vice-presidents and had represented the Council at the funeral and that a floral tribute had been sent on behalf of the Council.

Senior Councilors

Visits of senior councilors to local sections were reported as follows: S. W. Dudley, joint meeting of Hartford, New Britain, and New Haven sections, Bristol, Conn., January 14; Harte Cooke, Chicago section, January 18; James W. Parker, Toledo section, February 3.

Owing to the death of Dean Brigman, R. J. S. Pigott was asked to serve as senior councilor for Group V. James W. Parker, who would have succeeded Dean Brigman but who asked to be relieved because of service on the Executive Committee, offered to assist in the duties of the councilorship in the northern portion of Group V area.

Applied Mechanics Division

The chairman and secretary of the executive committee of the Applied Mechanics Division were designated representatives of the Society at the Fifth International Congress for Applied Mechanics, Cambridge, Mass., September, 1938. A set of by-laws prepared by the Applied Mechanics Division to govern the conduct of its affairs was approved.

Metals Congress Participation

An invitation of the American Society of Metals to participate in the National Metals Congress, Detroit, Oct. 17, 1938, was accepted with the understanding that the Society would not participate in the concurrent exposition.

New Conference Approved

Upon the recommendation of the Committee on Professional Divisions, a conference of pro-

fessional divisions and technical committees, to be held during the Annual Meeting when contacts can be made with the Council and the Group Delegates Conference, was approved.

Library Book Loans

Modification of the arrangement with the Engineering Societies Library under which books are loaned to student members through the honorary chairmen of student branches was approved. Details of the arrangement are reported on page 355 of this issue.

Retirement of Conrad Matschoss

The president and secretary reported that a letter of tribute and appreciation had been transmitted to Conrad Matschoss, life member, A.S.M.E., upon his retirement as director of the Verein deutscher Ingenieure.

Appointments

The following appointments were reported for record: To serve on committees and as representatives of the Society: Constitution and By-Laws, Carl E. Lindenmeyer, Jr., Junior Adviser (one year); Economic Status of the Engineer, C. J. Freund, chairman; Standardization, Sectional Committee on Allowances and Tolerances for Cylindrical Parts and Limit Gages, J. E. Lovely; Sectional Committee on Electric Welding Apparatus, Robert E. Kinkead; Boiler Code Committee Subcommittees, Ferrous Materials, Leo J. Mason and E. L. Robinson; Care of Steam Boilers in Service, P. B. Place, J. B. Romer, and W. B. Schroeder; Power Test Codes Committee, No. 19, Instruments and Apparatus, I. Melville Stein, No. 9, Displacement Compressors and Blowers, C. R. Houghton, No. 6, Steam Turbines, C. B. Campbell; Advisory Committee to Committee on Admissions (Fellow Grade), H. A. Lardner, chairman, Ely C. Hutchinson, Alfred Iddles, and J. H. Lawrence; Professional Divisions, Executive Committees, Graphic Arts, Fred W. Hoch (five years), Iron and Steel, C. W. Bennett (five years), R. J. Wean (2 years), Materials Handling, Maxwell C. Maxwell (five years); National Management Council, Frank L. Eidmann, alternate to J. A. Piacitelli; American Academy of Political and Social Science, annual meeting, Philadelphia, Pa., April 1–2, 1938, Coleman Sellers, 3rd, H. Birchard Taylor, and R. A. Wentworth; Vanderbilt University, Nashville, Tenn., Inauguration Third Chancellor, Feb. 3–5, 1938, Samuel B. Earle; Gantt Medal Board, W. D. Ennis.

Sessions on Gears, Tools, Metals, and Methods for A.S.M.E. Machine-Tool Meeting

Rochester, N. Y., May 10–12, 1938

AN UNUSUALLY well-balanced program of papers and inspection trips has been arranged for the meeting being planned by the A.S.M.E. Machine Shop Division for May 10–12, in Rochester, N. Y., with headquarters at the Sagamore Hotel.

Sessions are scheduled on gears and machine tools, foundry metals, and methods. Of particular interest are the two evening sessions, at the first of which, on Tuesday, Carl L. Bausch, vice-president in charge of engineering at the Bausch & Lomb Optical Co., in Rochester, will deliver an address on "Inspection Procedure." There will be keen interest in this address, not only because of its subject but also because Mr. Bausch is recognized as an authority in that field. The Wednesday evening session will be the occasion for an address on "Apprentice Training" by George B. Heddendorf of the education department of the International Business Machines Corporation. The work being done along these lines by that concern is of outstanding merit and Mr. Heddendorf is well qualified to give a competent and inspiring talk.

HOTEL SAGAMORE, HEADQUARTERS FOR MACHINE-TOOL MEETING

Plants to be inspected during this three-day meeting include the Gleason Foundry, Bausch & Lomb Optical Co., American Laundry Machinery Company, Eastman Kodak Company (Camera Works), Taylor Instrument Company, the Symington Company, and the Consolidated Machine Tool Corporation.

The detailed program is as follows:

TUESDAY, MAY 10

Morning

Gears and Machine Tools

A New Method of Producing Machine Screw Products, by E. W. Brinkman, Davenport Machine Tool Company, Rochester, N. Y.

Industrial Applications of Spiral, Bevel, and Hypoid Gears, by A. H. Candee, Gleason Works, Rochester, N. Y.

Afternoon

Inspection trips

Evening

Address on "Inspection Procedure," by Carl L. Bausch, of the Bausch & Lomb Optical Company, Rochester, N. Y.

WEDNESDAY, MAY 11

Morning

Foundry Metals

Steel Castings, by F. A. Lorenz, Jr., American Steel Foundries, Chicago, Ill.

Gray-Iron Castings, by A. C. Denison, Fulton Foundry & Machine Co., Inc., Cleveland, Ohio

Malleable-Iron Castings, by E. Touceda and J. H. Lansing, Malleable Founders' Society, Cleveland, Ohio

Afternoon

Inspection trips

Evening

Dinner Meeting, Sagamore Hotel

Address on "Apprentice Training" by George B. Heddendorf, of the International Business Machines Corporation

THURSDAY, MAY 12

Morning

Methods

Trends in Shop Practice and Drafting, by W. L. Bond, General Electric Company, Schenectady, N. Y.

What's New in Electrical Equipment for Manufacturing Operations, by W. D. Turnbull, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

Afternoon

Inspection trips

Caroline Hood Addresses Woman's Auxiliary

AT A MEETING of the Woman's Auxiliary to the A.S.M.E. held on the afternoon of March 10 at the headquarters of the Society, the announcement was made that a second local section of the Auxiliary had been organized in Cleveland, Ohio.

In this section there are eight charter members. Their meeting day is the second Friday of each month and for the April meeting they are enthusiastically planning a luncheon. Officers of the Cleveland group were elected: Mrs. H. A. Schwartz, chairman; Mrs. T. F. Githens, vice-chairman; Mrs. E. R. McCarthy, secretary; and Mrs. H. M. Hammond, treasurer.

After the business meeting Miss Caroline Hood, niece of the late Raymond Hood, one of the architects of Rockefeller Center, gave a particularly fascinating talk on the "Sky Gardens of Rockefeller Center." The gardens were established, Miss Hood said, for the enjoyment of those in the surrounding offices. The hand-colored slides shown of the International Gardens were beautiful reproductions.

Speakers Demonstrate Gas Engine in Shop Meeting of Toledo Section

At Meeting of March 16 Section Hears Dean Kimball's Talk on Great Inventions

MEETING in the erecting shop of the Rathbun-Jones Engineering Company in Toledo, March 3, seventy-five members of Toledo Section heard talks by George J. Rathbun, president of the company, and Edward Rathbun, member, A.S.M.E., and chief designer.

The session was unique in that the chairs and a blackboard were set up adjacent to the test floor upon which a 2000-hp eight-cylinder vertical gas engine was assembled ready for testing. In the course of the lecture on the design and operation of Diesel engines by the two speakers, the unusual features of the gas engine were discussed and demonstrated. Following the talks, the members had the privilege of inspecting the engine and shop equipment.

At a meeting held at the Foremen's Club on March 16, the assembled members got first-hand information on "Great Inventions and Their Economic Effect" as viewed by Dexter S. Kimball, past-president of the A.S.M.E., and dean emeritus of the school of engineering at Cornell University. Entertainment was furnished by the Ford Mountaineers.

Other Local Sections News

Anthracite-Lehigh Valley

A dinner meeting was held in Bethlehem, Pa., February 21, at which mutual problems of industry and education were discussed. Chairman J. T. Rea had so arranged 14 men at the speakers' table, including Harvey N. Davis, president, A.S.M.E., and guest speaker, that a leader in industry alternated with an educator. Brief remarks on the subject were given by Wm. M. Lewis, president of Lafayette College, C. C. Williams, president of Lehigh University, P. B. Eaton, representing the A.S.M.E. and the Engineers' Club of the Lehigh Valley, and J. M. Sylvester, assistant general manager of Bethlehem Steel Co. Following this, President Davis gave a splendid address, "The Engineer of the Future," which was well received.

A session at Pottsville, Pa., on February 25, featured two speakers, P. G. McVetty, member, A.S.M.E., and engineer in the research laboratories of the Westinghouse Electric & Manufacturing Co., and O. J. Horger, member, A.S.M.E., and research engineer with the Timken Roller Bearing Co. McVetty spoke on the "Creep of Steels at High Temperatures," and Horger discussed "Fatigue of Metals."

A.S.M.E. Calendar

of Coming Meetings

May 10–12, 1938
Machine Shop Practice Division Meeting
Rochester, N. Y.

June 6–9, 1938
Oil and Gas Power Division Meeting
Dallas, Texas

June 20–24, 1938
Semi-Annual Meeting
St. Louis, Mo.

September 5–6, 1938
Wood Industries Division Meeting
High Point, N. C.

September 12–16, 1938
Applied Mechanics and Hydraulic Divisions Cooperating in International Congress of Applied Mechanics
Cambridge, Mass.

October, 1938
Fuels Division Meeting jointly with A.I.M.E. Coal Division
Chicago, Ill.

December 5–9, 1938
Annual Meeting
New York, N. Y.

Baltimore

Design of welded structures was discussed by C. H. Jennings, research engineer of the Westinghouse Electric & Manufacturing Co., at a meeting in the Baltimore Engineers' Club on March 18.

Birmingham

The joint meeting of the Birmingham Section, A.S.M.E., and the local chapter of the American Foundrymen's Association, February 24–26, was attended by more than 650. It is significant that this annual foundry-practice meeting was started about five years ago by the section, and has since grown to such proportions that many people consider it on a par with national meetings.

George Ozley, chairman of the Birmingham Section, presided at the annual banquet. After a few remarks, he introduced the toastmaster, Prof. John M. Gallalee, who related many of his stories much to the enjoyment of the audience. Then the guest speaker, Dr. Spencer McCallie, headmaster of a school for boys, delivered a talk on the "Responsibility of a Father to His Children."

Thanks are due the Student Branch Committee, John J. Greagan, chairman, for the wonderful work which the members of the committee did in helping to reorganize the University of Alabama Student Branch. Close to 100 students attended the branch meeting held on February 28.

Boston

St. Patrick's Day in Boston was celebrated by the section at a dinner meeting at which Roy V. Wright, past-president of the Society, spoke. The "Engineer as a Citizen" was the subject of Doctor Wright's talk.

Bridgeport

Planes for private flying were described at a meeting of the section, March 11, by Alexander Klemin, member, A.S.M.E., and professor of aeronautical engineering at New York University, and by Everett B. Schaefer.

Cleveland

The Republic Steel Company's new 98-in. strip mill was described by H. B. Carpenter at the March meeting of the section.

Columbus

Following the showing of the motion picture, "Flow," F. T. Gleeson, member-A.S.M.E., and engineer with the Crane Co., led a general discussion on valves and pipe fittings at a session held at the Battelle Memorial Institute on February 18.

Dayton

A big day was had by the section on March 24 when the members paid a visit in the afternoon to the International Harvester Co. plant to look over the longest single assembly lines in the world, three in number, each 1250 ft long. Following a dinner in the evening at the Springfield Country Club, the subject of plastics and synthetic resins was discussed.

Detroit

On the evening of February 15, the Detroit Section was privileged to hear a talk on "Developments in the Design and Use of Gaging Equipment," presented by Clinton V. Johnson, member, A.S.M.E., who is an authority on the development of this subject. His talk covered gaging from the historical background to the most modern trends. Following the talk, a discussion was started by a lantern-slide presentation of "Ford Gaging Practice" presented by William F. Sherman, Detroit editor of *The Iron Age*.

Erie

Thursday, February 10, Dr. P. W. Bridgman of the physics laboratories, Harvard University, addressed the Erie Section on the subject, "Some Recent Investigations on High Pressures." The meeting, held in the auditorium of the Pennsylvania Telephone Co., attracted an audience of 96 members and guests.

Inland Empire

At a meeting held in the Davenport Hotel in Spokane, Wash., February 16, the life of the pioneer engineer, Leonardo da Vinci, was related by Henry Bertelsen, an architect.

MEMBERS OF ST. LOUIS SECTION AT FISHER BODY DIVISION, GENERAL MOTORS CO.

Ithaca

A joint meeting of the Ithaca Section and the Cornell Student Branch on March 18, had as guest speaker, Harte Cooke, vice-president, A.S.M.E., who gave a talk on Diesel engines.

Kansas City

Measuring by electricity was the topic of the talk given by E. S. Lee, General Electric Co., before the members of the section on March 10. The talk was similar in subject to the paper the speaker and C. M. Hathaway had published in the September, 1937, issue of MECHANICAL ENGINEERING and presented at the Erie meeting of the A.S.M.E. in 1937.

Los Angeles

The February meeting of the Los Angeles Section was one of the best ever held, especially since most of the 150 present were members. The paper on "Commercial and Engineering Developments in Gas-Compression Machinery" by David H. Conklin of the Ingersoll-Rand Company, proved to be most instructive. All types of air and gas-compression equipment, both reciprocating and rotary, were covered and opportunity given for 45 minutes of discussion at the close of the talk.

Louisville

With 25 members and 395 visitors present at the Kentucky Hotel, February 3, Phillips Thomas, research engineer with the Westinghouse Electric & Manufacturing Co., presented a lecture demonstration on such recent research discoveries as precipitron, an electrical device for filtering air of smoke; the electric eye, a device used commercially for sorting, materials handling, and burglar protection for homes and banks; and polarized light, its use and relation to the future of automobile night driving.

Mid-Continent

The subject of mechanization of antiaircraft artillery, as presented by Capt. E. L. Mannon, proved so interesting to the 76 members and guests present at the February 14 meeting, that all stayed more than an hour overtime to discuss the subject.

New Britain

A fellowship meeting, sponsored by the Junior Group, was held on February 16. R. Shaw described the activities of the group and B. S. Lewis presented a "History of the New Britain Section." Discussion between the junior and senior members followed. All in all, everybody had a good time.

New Haven

Discussing the "Influence of Working Conditions on Behavior of the Individual," at a meeting of the section on March 1, Dr. William Hovgaard, member, A.S.M.E., explained the effect of temperature changes, dust, light, etc., on the body processes. The 108 members and guests learned about the operation of the temperature central system of the body and how it is affected by changes in temperature.

North Texas

Meeting jointly with the Southern Methodist Student Branch on March 2, the members heard five students present papers in a competition to choose two representatives of the branch to compete at the student-group meeting to be held at Texas A. & M. College, March 28–29.

Philadelphia

At a meeting of the section on February 22, the student members of the various neighboring engineering schools, combined with the regular members to hear Harvey N. Davis, president of the A.S.M.E., and then listen to a talk on "Loxology," by Maxwell C. Maxwell.

The Professional Division's meeting at Drexel Institute on March 1 was devoted to the topic of "Fuels." A. W. Gauger, director of mineral industries research, Pennsylvania State College, lectured on "Fuel Supply and Utilization; an Ever-Changing Panorama." There were 65 present at this session.

Raleigh

Monday evening, February 14, a joint dinner meeting took place with the Raleigh Engineers' Club, for which the Raleigh Section provided the program. G. G. Fornes of the mechanical-engineering department of North Carolina State College, assisted by M. C. Brennon, senior student at the school, presented a photoelastic demonstration.

St. Louis

On the evening of February 25, the St. Louis Section held its meeting at the St. Louis plant of the Fisher Body Division, General Motors Company. Although the plant was not in operation, the resident manager, Vincent M. Dirkes, had a considerable crew of workmen spotted around various parts of the plant doing actual production work on important steps in the assembly of bodies. Following the inspection trip through the factory, the 150

Itinerary of President Harvey N. Davis

April 4–May 6

April 4: Western Washington Section
Group VII—Northwest Unit Student Conference, Seattle, Wash.

April 6: Inland Empire Section

April 8: Montana State College Student Branch

April 11: Group VII—Central Unit Student Conference, Fort Collins, Colo.

April 12: Colorado Section

April 13: University of Wyoming Student Branch

April 14: University of Nebraska Student Branch

April 15: Group VI—Northern Unit Student Conference, Omaha, Neb.

April 16: Nebraska Section

April 18: Group V—Mid-West Student Conference, Milwaukee, Wis.

April 19: Rock River Valley Section

April 20: State University of Iowa Student Branch
Tri-Cities Section

April 21: Iowa State College Student Branch

April 22: Armour Institute Student Branch
Northwestern University Student Branch

April 24: University of Illinois Student Branch

April 25: Rose Polytechnic Institute Student Branch

April 26: Purdue University Student Branch
Louisville Section
University of Louisville Student Branch

April 28: Case School of Applied Science Student Branch
Cleveland Section

April 29: Akron-Canton Section

May 2: Group III—Student Branch Conference, Toronto, Ont.

May 4: Detroit Section

May 6: Group I—Student Branch Conference, Durham, N. H.

members assembled to view some motion pictures about automobile production and hear Mr. Dirkes discuss the various problems which arise in his plant. Following this talk, the members visited the adjacent plant of the Chevrolet Motor Company.

The pleasure of welcoming Harvey N. Davis, president of the A.S.M.E., Ernest Hartford, assistant secretary of the Society, and Mrs. Hartford, was accorded the section the evening of March 8 at a dinner dance in the Crystal Room of the Coronado Hotel. Next morning, the *St. Louis Globe-Democrat*, in its version of Doctor Davis' talk, quoted him as follows: "The destiny of the engineer is to increase the standards of living—not to make money," and he will become in the next 25 years that needed balance wheel between capital and labor.

San Francisco

More than 100 members and guests attended the meeting on February 24 to learn about mining in California, with special reference to the mechanical features of modern gold dredges, from Herbert A. Sawin, member, A.S.M.E., V. E. Bramming, Pan-American Engineering Co., and Corey C. Brayton, American Manganese Steel Co. Motion pictures as well as slides were used to illustrate various dredges and their construction details, operation, etc.

Schenectady

The question, "Are the Policies of Current Labor Organizations Constructive?" was answered at a meeting of the section by six speakers, T. C. Johnson, A. B. Wellborn, M. J. Leding, A. W. Brunot, C. Concordia, and B. R. Prentice.

South Texas

Rice Institute was the scene of the meeting of the South Texas Section on February 25, when B. B. Morton, International Nickel Co., enumerated the alloy steels and irons available for the use of mechanical engineers.

Syracuse

Sixty years of mechanical engineering was the subject of the talk presented on February 17 by Edward N. Trump, fellow, A.S.M.E. He reminisced on his experiences as a mechanical engineer from the time of the Philadelphia Exposition in 1876 to the present, and cited many incidents which showed the enormous strides made in the profession since that date.

Washington, D. C.

Meeting at the Cosmos Club on February 8, the 85 members and guests listened to three talks on Diesel engines given by O. D. Trieber, Paul Weeks, and E. D. Newell. Modern high-speed injection engines and various types of superchargers and injectors were discussed.

West Virginia

How to choose the correct transmission method was described by William Staniar, member, A.S.M.E., February 28, at a meeting held in the Ruffner Hotel, Charleston, W. Va. He outlined the different types of mechanical transmissions, gave the characteristics of each and their applications. Recent developments were discussed and explained.

Western Washington

A session held in Seattle, February 15, featured talks by Harry J. McIntyre on "The Height of Wastefulness Is Useless Motion," Paul Bliven on "Facts About Patents, Copyrights, and Trademarks of Interest to Engineers," and Ralph Dyer on "High Speed Centrifuges for Oil Purification and Other Industrial Applications."

Worcester

The A.S.M.E. 50-Year pin was presented to Henry P. Merriam by the Worcester Section at its February meeting, since he could not get down to New York in December to receive it at the annual meeting. Following the presentation, the largest audience ever to turn out for a section meeting, heard Maxwell C. Maxwell give his talk on "Loxology."

The Technical Committees Report Progress and Much Activity

Committee Week in Rochester; Tolerance Table Revision Considered

AS AN indication of the widespread activities in the fields of research, standardization, and safety sponsored solely or jointly by the A.S.M.E. and carried on by hundreds of committees and subcommittees, the following reports will acquaint members with what is going on in the committee rooms. Many reports, of course, cannot be released until fully reviewed and completed and therefore, in many cases, the only evidence of the tremendous amount of work done by a committee will be found in the few pages of the pamphlet containing the accepted code or standard.

Committee Week in Rochester

Throughout the week beginning March 7, the annual spring group of A.S.T.M. committee meetings was held at the Seneca Hotel in Rochester, N. Y. Some of the committees holding sessions are under the joint sponsorship of the A.S.M.E., A.S.T.M., and possibly others, and included the Special Research Committee on the Effect of Temperature on the Properties of Metals, which was formed to encourage the investigation and accumulation of data on the properties of metals at extremely high and low temperatures. Another was the Sectional Committee on the Standardization of Wrought-Iron and Wrought Steel Pipe and Tubing, of which H. H. Morgan, member, A.S.M.E., is chairman and A. M. Houser, D. S. Jacobus, H. B. Oatley, and Ludwig Skog are the Society's official representatives.

New Committee Meets First Time

A new committee to develop standard specifications for thermal insulating materials was organized by the A.S.T.M. and held its organization meeting in Rochester, March 10, with J. H. Walker acting as temporary chairman. Representing the A.S.M.E. on this body as its official representative is R. H. Heilman, member, A.S.M.E., and senior industrial fellow, Mellon Institute of Research. Other A.S.M.E. members on the committee are J. H. Walker, E. T. Cope, E. A. Allcut, and H. C. Dickinson. While the field of thermal insulating materials is quite broad, the members

Courtesy St. Louis Convention Bureau

THE FAMOUS LINDBERGH COLLECTION AT THE JEFFERSON MEMORIAL IN ST. LOUIS, WHERE THE A.S.M.E. IS TO HOLD ITS SEMI-ANNUAL MEETING

propose, for the time being at least, to confine the scope of the committee's activity to materials of the pipe-covering type.

Tolerance Table Revision Considered

The members of the Sectional Committee on Allowances and Tolerances for Cylindrical Parts and Limit Gages, J. E. Lovely, chairman, are now voting on two questions, presented by the subcommittee of which R. E. W. Harrison is chairman. First, shall tables of hole limits, shaft limits, and recommended fits in the basic hole and shaft system as given in the form presented with the inquiry, be distributed for general criticism and comment, as a proposed revision of the tables given in the American Tentative Standard (B4a-1925) on Tolerances, Allowances, and Gages for Metal Fits? The second question to be answered is whether any further consideration is to be given to the inclusion in the proposed revision of a "constant maximum hole" system (meaning that the tolerances of all holes of a given nominal size extend downward from a common high limit).

Oberg Visits Leipzig Fair

Erik Oberg, chairman of the Technical Committee on the Standardization of T-Slots and member of the Sectional Committee on Standardization of Small Tools and Machine-Tool Elements, visited the Leipzig Spring Trade Fair in Germany, March 6–14, where he was particularly interested in the machine-tool exhibition. Other countries visited by him included Czechoslovakia and Switzerland.

Surface Qualities

Meeting at headquarters of the Society on February 18, the executive committee of the Sectional Committee on the Standardization and Classification of Surface Qualities, J. R. Weaver, chairman, decided to prepare a draft of a proposed standard for presentation to industry together with a complete bibliography.

It is expected to have the form ready for submission to the executive committee for review prior to the next meeting which is scheduled to be held in Paterson, N. J., April 15, 1938. Mr. Weaver was recently elected to the chairmanship of the committee, this office having been made vacant by the resignation of Col. H. K. Rutherford.

Committees to Meet in New York

A group of technical committee meetings will be held in the Engineering Societies Building during the week of April 11–15. Fifty-eight committees and subcommittees have been asked to signify their intentions as to their desire to hold meetings.

Safety Code for Cranes and Hoists

Progress is being made toward the completion of the new Safety Code for Cranes, Derricks, and Hoists. Copies of the September, 1937, draft were distributed for criticism and comment in October, 1937, and in March, 1938, these were supplemented by copies of a set of definitions.

Representatives on Committees

At a meeting of the A.S.M.E. Standardization Committee, it was stated that the representation on the following A.S.M.E. sponsored sectional committees is inadequate: Bolt, Nut, and Rivet Proportions (three representatives needed); Plain and Lock Washers (two needed); Stock Sizes, Shapes, and Lengths for Hot and Cold Finished Iron and Steel Bars; and Foundry Equipment and Supplies. The Committee on Miscellaneous Coal-Handling Equipment, for which the Society is not a sponsor but is a cooperating organization, is also without any A.S.M.E. representative. The Standardization Committee will appreciate receiving for its consideration the names of members who would be suitable representatives of the Society on any of these committees.

Nominations for committee members may be addressed to the Secretary of the Society.

Revised Codes Now Available

The Power Boiler Code, published February, 1938, presents up-to-date information on the design and construction of power boilers, materials used in their construction, installation, inspection and safety requirements. An appendix contains explanatory matter and much valuable data for both users and manufacturers of boilers. This code may be obtained by members from headquarters of the Society at a discount of 20 per cent on the list price of $2.50.

The API-ASME Code on Unfired Pressure Vessels for Petroleum Liquids and Gases published March, 1938, contains rules and regulations governing inspection, repair, and allowable working pressures of vessels in service, suggestions regarding internal structures, corrosion allowances, and protective linings, etc. This third edition is available for $1.

Junior Group Activities

Second Annual Ladies' Night Given by Detroit Juniors

THE DETROIT Junior Group held its second annual ladies' night, a dinner party, at the Detroit Edison Boat Club on Thursday evening, February 24. Eighteen couples, including Dean and Mrs. C. J. Freund, attended the party. After dinner the group took advantage of the clubhouse to complete the evening; some enjoyed cards and games in the lounge while others danced. Mr. Lentz, a Junior member, entertained the group with an excellent display of color photography, showing colored slides of his recent trip through Cuba and some miscellaneous shots, all of which were most interesting. The party was a real success, everybody had a good time, and it is hoped to have a similar party again next year.

Mid-Continent Juniors Plan President's Visit

PLANS FOR the pending visit of Dr. Harvey N. Davis, A.S.M.E. president, held the center of attention at the February meeting of the Junior Group of the Mid-Continent Section. Henry Schaefer told the members present that the Juniors had been given the responsibility of putting on a dinner and getting out a crowd.

After arrangements had been made to escort President Davis from the University of Arkansas, at Fayetteville, to Tulsa, it was decided to hold the dinner at the Chamber of Commerce dining rooms, under the direction of a committee of three: John Eaton, Fred Manton, Tom Webb. Another committee of three (Fred Manton, Fred Stewart, and Jack Laudermilk) was appointed to arrange for entertainment.

The secretary explained that this was to be a joint meeting with the Engineers' Club of Tulsa, and it was agreed to meet with Junior members of the Club to settle the details of cooperation.

Cleveland Group Holds Members' Night Banquet

THE FIRST annual Members' Night banquet and meeting of the Cleveland Junior Group was held February 24 in the Bingham Library of the Case School of Applied Science. Vigorous discussion filled intervals in the excellent dinner which was followed by an informal lottery to determine the lucky winner of a free meal.

High spots of the evening that followed were three talks on widely diversified subjects. "Welded-Tube Products" were considered by D. A. Trescott, sales engineer with Steel and Tubes, Inc. After sketching the history of tubing and its uses, he described the way in which strip steel is formed into tubing by a series of rolls and then resistance-welded. This process was demonstrated graphically in a film, and a second movie illustrated the galvanizing of steel tubes.

Experiences in mining gold by the hydraulic placer method were recounted by C. M. Hannum in a talk, "Three Years in a Gold Mine." The mine in question was located on a creek in the mountains of California some 300 miles north of San Francisco. Water used to cut away the gold-bearing soil was brought from a reservoir high in the mountains by a system of flumes and conduits, the natural head making unnecessary any pumping equipment. Photographs in black-and-white and color

helped give an idea of the nature of the country and the mining methods employed.

The last talk was given by G. B. Carson, assistant professor of mechanical engineering at Case, who reviewed extensive researches he has made in "Streamlining Ocean Vessels." Data were given showing the wind resistance of the hull and superstructure of a conventional ship as compared with that of a streamlined ship, as measured by model tests. This difference in wind resistance becomes appreciable and economy of operation is affected considerably at the higher speeds proposed for future ships.

The fine program, good attendance, and general enthusiasm displayed made this initial affair a fitting precedent for future annual banquets.

Junior Paper Features Metro Seminar Meeting

AIR conditioning proves to be of continuing interest to many members of the Metropolitan Junior Group, and the seminar devoted to this subject meets monthly, attracting an audience between forty and fifty. Programs are arranged, to suit the pleasure of the members, by Sidney Davidson, chairman.

"Application of Dehydration to Air Conditioning" was the topic for the meeting held March 8 at the Engineering Societies Building. Sam Shoor, a junior and an engineer with the Carrier Corporation, presented the principles underlying the application of silica gel and lithium chloride in the dehumidification phase of air conditioning and discussed current installation practice. An active discussion followed.

Catalog Committee Wants Cooperation of Juniors

THE COMMITTEE in charge of preparation and publication of the Mechanical Catalog is conducting a survey to determine the extent of its use, members' opinions as to completeness of its contents, and suggestions for improvement of its service.

F. L. Bradley, chairman of the committee, will welcome suggestions from Juniors. Letters should be sent to Mr. Bradley at 29 West Thirty-Ninth Street, New York, N. Y.

A survey questionnaire has been mailed to members to obtain their response, but those not having received it are urged to write concerning any constructive ideas they may have concerning the catalog.

Boulder Dam Film Shown at South Texas Meeting

FORTY-ONE members and visitors attended the meeting of the South Texas Junior Group, held January 28 in the Mechanical Laboratories Building, Rice Institute. John Doggett Jr., vice-chairman of the Group, presided.

A. J. Kerr of Tulsa, Oklahoma, a member of the A.S.M.E. Standing Committee on Local Sections, attended the meeting and was called upon by Mr. Doggett. In his brief talk, Mr. Kerr pointed out that the Spring, 1939, meeting of the Society will be held in New Orleans and urged those who desired to attend a national meeting of the A.S.M.E. to take advantage of this opportunity. He also mentioned the fact that the A.S.M.E. will be sixty years old in 1940 and that a special nation-wide program celebrating the ocasion was being planned for April of that year.

The meeting continued with the showing of a film describing the construction of Boulder Dam. This film, the property of the Ingersoll-Rand Company and loaned to the Group, was obtained from the U. S. Bureau of Reclamation. Just prior to the running of the film which traced work on the giant dam from the construction of work camps to completion, W. F. Dalton of the Ingersoll-Rand Company's Houston office gave a short talk.

Juniors to Present Papers at Los Angeles Meeting

THREE JUNIORS will take an active part in the program of the Spring Meeting of of the A.S.M.E. to be held at Los Angeles, March 23–25.

G. F. Wislicenius and Igor J. Karassik, of the Metropolitan Section and the Worthington Pump and Machinery Corp., will join with R. M. Watson of the same company in presenting a paper on "Cavitation Characteristics of Centrifugal Pumps Described by Similarity Considerations." Mr. Wislicenius received his education and held various engineering jobs in Germany until 1928 when he became associated with Worthington. Carnegie Tech granted Mr. Karassik both the B.S. and M.S. degrees in mechanical engineering, the latter in 1934. Since then he has been employed by Worthington.

The other junior paper is also in the field of hydraulics, being on "The University of California Pump-Testing Laboratory," and written by Richard G. Folsom, of the department of mechanical engineering, University of California, Berkeley, and a Junior of the Society. Mr. Folsom received his B.S. from California Tech in 1928, and M.S. in 1929. After a year in industry he turned to teaching, his present field. Mr. Folsom's paper appears in this issue, pp. 301–305.

Juniors and Guests Share Kansas City Programs

PAPERS by Juniors and talks by guest speakers have featured recent meetings of the Kansas City Junior Group. At the February meeting, Charles Loetel, of the Group, spoke on the "Chemical Treatment of Water," discussing methods of treatment for boiler operation. The guest speaker at this meeting was Mr. Rodgers, who presented his observations of Russian life in a talk "Another Engineer Looks at Russia." Based on experiences during a period of employment in a Russian aircraft factory, the talk was highly interesting, and an exhibition of photographs made in Russia heightened this interest.

Two Junior papers and a guest speaker were on the program of the January meeting of the Group. Ted Downs, Junior, discussed "Sewage Treatment" describing several existing sewage-disposal plants, and considering the use of the gas for power generation. Another junior, Jess Carmichael, speaking of "Gasoline Test Methods," explained how octane rating for various fuels is determined, and described the type of engine used by the Ethyl Gasoline Corporation. The guest speaker was Benjamin Rollins, vice-chairman of the Kansas City Section, who took as his subject, "The Engineer in Public Affairs."

Business Meeting and Film Engage Metro Junior Group

To Compile Data for History of Group

THE PRINCIPAL March meeting of the Metropolitan Junior Group was devoted to business. Nominations for officers for the coming year were announced by Charles F. Pray, chairman of the Nominating Committee, and the meeting was thrown open for nominations from the floor. The employment Advisory Service Committee, headed by E. Caruthers, presented a report on its activities and considerable time was devoted to a consideration of the results of the annual survey form, as they affect future plans and activities of the Group.

Heat and Its Control

"Heat and Its Control," a talking motion picture, was the subject of the Group's featured February meeting. Presented in conjunction with a talk by George F. Habekotte, of the Johns Manville Co., the film traced the story of heat from the ancient days of sun worship to modern methods of heat conservation. It included such high lights as the rise of the steam engine, and interesting visualizations of the nature of heat and its utilization. The chairman of the meeting was Sam Shoor, and the arrangements were made by H. H. Edwards, chairman of the Program Committee.

M. W. Deutschman led the National Defense seminar in a discussion of methods of obtaining commissions in the Organized Reserve, at the seminar's March 9 meeting.

Metro Juniors to Compile History of Their Group

The Metropolitan Junior Group's chairman, W. G. Hauswirth, has appointed a committee to compile data for and write a history of the group. The members are: L. F. Zsuffa, chairman; W. F. Carhart, and A. E. Blirer.

It is anticipated that other Junior groups that do not already have an up-to-date history will have similar papers written, and plans call for a general history of the entire Junior movement. The general plan will be in charge of Mr. Zsuffa, who is editorial assistant of the A.S.M.E.

With the Student Branches

St. Patrick, Patron Saint of Mechanical Engineers, Honored on March 17

Dances, Smokers, Exhibits, and Parades Order of Day at Middle-Western Schools

ST. PATRICK, is honored not only by the Irish on March 17, but also by all mechanical engineers, since he is known as the first mechanical engineer. How this information has been carried down the ages from the fifth century is not known, but it is common hearsay that St. Patrick made the first worm drive. The A.S.M.E. has honored him by adopting his four-leaf clover as the badge of membership in the Society.

Minnesota Student Branch claims that the custom of honoring St. Patrick started there thirty-five years ago with the discovery of a stone. The "old timers" of the class of '03 proudly relate how one of their group was casually watching a workman loading stones uncovered during the excavation for the mechanical-engineering building, when one of the stones rolled from the load and fell on his foot. Strangely the student felt no pain. He was dumfounded momentarily but regained his composure and picked up the stone on which was an inscription containing six words in a strange language. Luckily the student was of Irish birth and able to translate the inscription which read, "Saint Patrick was first mechanical engineer."

The matter was formally taken up the next day at a meeting of the seniors who passed the following resolution: Whereas St. Patrick was the first mechanical engineer, therefore be it resolved that the mechanical-engineering department take a holiday and celebrate in a body on March 17. Through the years, the mechanical-engineering students have celebrated the day with such enthusiasm and success that all the other engineering students have finally asked to join in the ceremonies.

According to last year's program, the celebration started with "open house" for parents on March 15. On the following day all engineering classes were excused so that the students might concentrate their efforts in putting the finishing touches on the floats to be entered in the Engineers' Parade on the morning of St. Patrick's Day. In the afternoon, teams sponsored by the various engineering societies responded to the beat of a drum and competed in a series of athletic contests for a trophy. The traditional "dansant" and tea was run simultaneously with the athletic meet. The celebration culminated in the gala "Engineers' Brawl" at a prominent Minneapolis hotel.

Illinois Branch reports that last year's affair in honor of St. Patrick consisted of a ball held in the school gym. Among the features were a dancing and singing co-ed chorus, a minstrel show by members of the dramatic society, and individual numbers by men and women attending the celebration. As a climax to the evening, each engineering society nominated a girl to be the consort of St. Patrick and wear his crown, the winning damsel selected by popular acclaim of the assembled celebrants.

According to our informants, similar celebrations were held at Michigan, Nebraska, North Dakota, Texas Tech, Arkansas, and several other schools whose names cannot be recalled at the moment. However, the spirit is spreading to the East where Villanova Branch held a smoker on the patron-saint's day.

Student Members Given Library Loan Privilege

AN ADDITIONAL service to members of student branches by the Society was recently inaugurated when arrangements were completed between the Engineering Societies Library and the Council to extend the loan privilege to student members. The only condition is that these loans shall be made through the honorary chairman and not directly to the student himself.

A.S.M.E. members, including students, have the privilege of borrowing from the Library for a small fee any engineering book published in America during recent years. Books in foreign languages, periodicals, transactions of societies, etc., cannot be supplied. However, abstracts, translations, and photostat copies of these may be obtained through the Library's research and photoprint department at a nominal charge.

A rental of five cents a day will be charged for each volume borrowed, but an allowance will be made for time in transit so that distant members may be on the same footing as those in New York. Transportation and insurance costs shall be borne by the borrower.

The Library will be responsible for losses during shipment to the borrower. In turn, the borrower will be responsible for the return of the books to the Library and for any damage, except ordinary wear and tear.

Members who wish to buy these books may do so by notifying the Library within ten days upon receipt of the book, in which case no rental will be charged. In cases where a single loan involves a value of more than fifteen dollars, approval by the Secretary of the A.S.M.E. will be necessary.

Technique of Applying for Job Shown at A.I.M.E. Meeting

ONE OF the most interesting sessions at the annual meeting of the American Institute of Mining and Metallurgical Engineers, was the student conference held the morning of Feb. 15, 1938. With more than 150 student representatives, personnel directors, faculty advisers, professors, and prospective employers present, three students, picked by lot, were interviewed individually on the stage of the auditorium by industrial personnel directors for positions in the steel, petroleum, and mining industries.

Preparation for Interview

Prior to the demonstration, Howard Lee Davis, director of technical employment for the N. Y. Telephone Co., gave a half-hour talk on the necessary preparations for an employment interview, which was patterned after the contents of a pamphlet written by him for students. ("Preparation for Seeking Employment," by H. L. Davis, John Wiley & Sons, New York, N. Y. Twenty-five cents.) Mr. Davis stressed the point that technical students should apply the engineering method to the problem of getting a job by analyzing what they want to do and where they want to work, based on a long-range viewpoint.

Factors Considered During Interview

All interviewers were of the opinion that the applicant most likely to impress them is one who knows and can tell in a few words his experience and reasons for seeking a position with the company. The problem to be solved by the interviewer, according to the summation by O. W. Eshbach, personnel department, American Telephone and Telegraph Co., is to find out if the character and experience of the applicant seem satisfactory, and if so, to determine for what position in the company the applicant is best fitted. If the job-seeker has any questions, he should be prepared to present them at the interview.

New U. S. Steel Corporation Plan

In the course of the demonstration, one of the interviewers, E. M. Stephens, industrial-relations department, U. S. Steel Corporation,

Pittsburgh, Pa., described the new student cooperative plan recently inaugurated by his company whereby engineering students are given summer jobs at the end of their sophomore and junior years. Most of the graduate engineers selected for permanent positions are taken from this group; however, others may be considered if qualified.

Grace Scholarships Awarded to South American Students

SIX ENGINEERING scholarships, annually granted by W. R. Grace & Co. in collaboration with the General Electric and Ingersoll-Rand Companies, were just awarded to engineering-school graduates in Peru and Chile.

The students are selected each year by a committee in each country consisting of the American ambassador, an executive of W. R. Grace & Co., and representative educational leaders and government officials. Only graduate students, speaking English, are eligible. During his eight to eighteen months' stay in the United States for study and practical experience in his particular branch of engineering, each student receives a scholarship allowance of $125 a month for living expenses.

Glasgow Speaking Contest at Stevens, April 13

FINAL and definite plans have been completed, according to an announcement received from Stevens Institute of Technology, for the Glasgow Speaking Contest for which Arthur G. Glasgow, life member, A.S.M.E., and chairman of Humphreys & Glasgow, Ltd., London, England, has offered an annual prize of $100.

The initial contest will take place on Wednesday evening, April 13. Preliminary tryouts and eliminations will be conducted so that about six men will compete in the final contest for first, second, and third prizes of $50, $30, and $20, respectively. The contest is open to all undergraduates and is on a topic that is "of interest to engineers," technical or nontechnical.

Branch News

Alabama Branch Assisted by Section

MORE THAN 100 students turned out to listen to Roy Thomas, assistant chief engineer of the Tennessee Coal, Iron & Railroad Co., describes the new tin mill built by the company at Fairfield, Ala. This meeting of ALABAMA UNIVERSITY BRANCH was arranged with the assistance of John J. Greagan, Paul Wright, and Prof. J. M. Gallalee of the Birmingham Section. The committee is now arranging for a joint meeting in April of the Birmingham Section, ALABAMA TECH BRANCH, and ALABAMA UNIVERSITY BRANCH. It is anticipated that one or more members of each student branch will present papers.

A. & M. COLLEGE OF TEXAS BRANCH held a meeting on Washington's Birthday at which R. A. Grimmer gave a short talk on the comforts of air conditioning. Preceding the presentation of the paper, a film entitled, "The Power Within," and describing the construction of an automobile, was shown.

ARIZONA BRANCH expects Robert Parsons to present the prize-winning paper at the student-group meeting to be held in Los Angeles. Richard Lynn, chairman of the branch, has been selected by his fellow members as the official delegate to the meeting.

Monson to Speak for Brooklyn Poly

At a regular meeting of BROOKLYN POLY BRANCH, Arthur Monson spoke on "The Comparative Performance of a C. F. R. Engine Running on City Gas and Gasoline With Varying Compression Ratio," and George Sauselle presented a paper on the "Resistance of Tube Banks to the Flow of Fluid." Rating sheets were filled by members of the audience and when the final count was taken, Monson was found to be the choice of the majority to represent the branch at the student-group meeting to be held in Philadelphia, Pa.

BUCKNELL BRANCH also held a meeting on Washington's Birthday at which a sound motion picture on "Flow" was presented.

CALIFORNIA BRANCH conducted a meeting off the campus when 73 members went to Oakland to learn about motor fuels and tetraethyl from the representatives of the Ethyl Gasoline Corporation.

CALIFORNIA TECH acted as host to members of the other engineering societies' student branches at a showing of the motion picture, "Heat and Its Control."

Rockets Featured at Case Meeting

A special evening meeting was held by CASE BRANCH for the purpose of having E. Loebell of the Cleveland Rocket Society present an illustrated lecture on "Rocket Developments."

CINCINNATI BRANCH's chairman, Krell Bosler, reports that the corresponding secretary has gone on a cruise, which is the reason no news about the branch has appeared in these columns. In his letter, Krell tells of the reception given by the student members to President Davis on his recent visit to the school, of a meeting at which Doctor Luther of the faculty told of his trip to Europe, and of a session at which films on welding and flame cutting were shown.

C.C.N.Y. Hears Doctor Gilbreth

C.C.N.Y. BRANCH held a smoker which featured refreshments, movies, smokes, and the usual air of good fellowship. A joint meeting was held with the A.I.E.E. student branch which was attended by 120 students. The guest speaker was Millard H. Gibson, consulting engineer, who spoke on "What Industry Looks for in the Graduate Engineer."

On March 10, Lillian M. Gilbreth, member, A.S.M.E., spoke on "Time and Motion Study" at a general meeting which was attended not only by students from C.C.N.Y. but by A.S.M.E. student members from Brooklyn Poly, Columbia, Cooper Union, Newark, N.Y.U., Pratt, and Stevens.

COLORADO BRANCH in conjunction with other engineering societies on the campus conducted a joint meeting at which films on the building of the Golden Gate Bridge, and on valves and fittings were shown.

COLORADO STATE BRANCH had Frank Sabec give a paper and show slides about the San Francisco–Oakland Bridge.

COOPER UNION BRANCH members heard a talk by Jack Schiller, chairman of the branch, on the manufacture of tin cans for beer. Jack showed samples of the cans in various stages of manufacture but did not have any samples of the contents.

Cornell Holds Speaking Contest

More than 75 members and guests attended an evening meeting of CORNELL BRANCH at which various members presented papers in competition for a prize which was a copy of the biography of Professor Thurston. George C. Brainard discussed "Assembly Conveyor Problems," C. M. Allbright described "Sound Reproduction," Richard Marchant talked about "Diesel Engines," and Edward V. Dorr showed the relation between the metallurgist and the engineer. According to the judges, the winner was Brainard.

FLORIDA BRANCH in preparation for the annual Engineer's Fair, has formed the following committees: Projects, K. W. Klotz, chairman; shop, G. A. Israel, chairman, mechanical laboratory, G. E. Remp, chairman; and program, E. E. Bisson, chairman.

UNIVERSITY OF IOWA BRANCH had members present papers at several meetings. Those speaking were S. A. Karche, H. C. Forestner, R. C. Richards, William Trigg, and E. W. Waters.

Iowa State Has 150 at Meeting

Speaking at a meeting sponsored by the IOWA STATE BRANCH in cooperation with the student branches of other engineering societies, T. R. Agg, dean of the engineering college and director of the A.S.C.E., traced the history of the engineering profession and showed its relation to the engineering societies. "No engineering records have been found dating before the eighteenth century," he said, "and since then professional engineering societies have been responsible for most of the recording of engineering data." At another meeting, Daniel Edwards told of the manufacture and use of precision gages, and Russell Kilgore described the handling of freight by the railroads in Chicago.

KANSAS BRANCH presented an educational program featuring a film on the production of steel. Another meeting had Professor Wheeler of the psychology department as the speaker. He connected the climatic cycles of all time with changes in government, art, and other human relationships. From a study of these cycles he predicted a coming stabilization of

society together with an increase in engineering problems.

Kentucky Branch considered itself fortunate to have Dean J. H. Graham speak on the subject of chlorinated diphenol and his connection with its discovery and subsequent development. A later meeting featured a discussion, led by T. R. Terry, about articles in the latest issue of Mechanical Engineering and their value to engineers.

Lewis Gets Write-Up in Chicago Paper

Lewis Branch had a meeting in which the members were shown the necessity for clear expression in speaking and writing by John Howatt, chief engineer of the Chicago Board of Education and past-president of the A.S.H.& V.E., who was introduced by Alex D. Bailey, past vice-president of the A.S.M.E. The talk, which merited a 10-in. column in the *Chicago Daily News* and a 12-in. column in the school paper, included such statements as "Engineers, if they are what their title implies, must be logical thinkers. Generally they are better writers than they are speakers. They are woefully weak in expressing themselves orally and do not do themselves justice through this means."

Louisville Branch were told that "There is no Useless Science" by J. L. Hammond. The subject of pulverized-fuel equipment was discussed by Sabel Bloch.

Maine Branch members got first-hand information about rail cars and Diesel locomotives from E. K. Bloss, supervisor of equipment for the Boston & Maine, R.R.

Maryland Branch members are busy making plans for sending speakers and delegates to the student group meeting to be held in Toronto. The following members of the Branch were selected as chairman of the committees mentioned: By-laws, H. Alfred Essex; meetings and entertainment, J. T. Andrews; advertising, A. Korab; and awards, M. N. Collison.

Michigan Tech Branch members, numbering 48, heard A. McKenzie present a paper on the properties, uses, and manufacture of a special steel alloy.

150 Attend Michigan State Meeting

With 50 members and 100 guests present, Michigan State Branch conducted a meeting which featured Miles A. Kinley, Ethyl Gasoline Corporation, in a talk and demonstration of various kinds of fuels, and a motion-picture film about the story of ethyl gasoline.

Mississippi State Branch had Major Heilfron tell about the part which engineers play in military defense. A later meeting was the joint undertaking of the student branches of the A.S.M.E., A.I.E.E., and A.S.Ch.E., and featured Dr. B. M. "Buzz" Walker, former engineering-school dean and college president, who told of how the engineering school at Mississippi State was organized.

Missouri Branch has a small membership, so when five new members are signed up at one meeting, that is news. It is even bigger news when the membership is thinking of attending the student group meeting in Nebraska in a body.

Chicago A.S.M.E. Office Assists Student

When Don Payne, chairman of the Nebraska Branch, visited Chicago recently, he asked the Mid-West Office of the A.S.M.E. in Chicago to arrange for him to visit several plants in the locality. By making a few calls, the office made it possible for Don to visit the Carnegie-Illinois plant and the Museum of Science & Industry. All student members are urged to use the facilities available for their use at the Society's Mid-Continent Office in Tulsa, Mid-West Office in Chicago, and Headquarters in New York, when visiting those cities. A meeting of the Nebraska Branch was devoted to a talk by Paul Doubt on "Hydraulics of Varied Flow in Prismatic Channels."

Newark Branch had as speaker, Morris Andrada, who presented a paper on the art of material handling.

New Hampshire Branch presented Webster Tallmadge, member, A.S.M.E., and president of Webster Tallmadge and Co., Inc., who gave an illustrated lecture concerning zone heating and orifice-controlled radiators in large buildings. The following week, Richard Clement, who before his graduation last June was a member of the branch, told of the training course which he is pursuing with the Babcock and Wilcox Co.

A.S.M.E. Members Inspect Diesel Train

When the new streamlined Santa Fe Diesel train came through Albuquerque on February 16, only the passenger cars were opened for public inspection. The student members of the New Mexico Branch by mentioning their affiliation with the A.S M.E. to W. R. Harrison, superintendent of the Santa Fe shops in Albuquerque, were introduced by him to the superintendent of the railroad's Diesel division who was traveling on the train and took it upon himself to take the boys through the Diesel locomotive units and explain the various pieces of equipment.

New York University Branch (aeronautic division) was required to hold a meeting, featuring films on the "Theory of Flight," in the school's chapel in order to accommodate the crowd which turned out for the session. The films, covering the phases of lift, lift-over-drag ratio, streamlining, and stability, were, according to Eli S. Newberger, secretary, elemental, but covered the basic aerodynamic theories satisfactorily.

New York University Branch (evening division), in order to help the members, has formed a committee to sponsor a campaign to develop a bigger and better engineering library at Washington Square, which is located about 12 miles away from the main engineering library at University Heights.

Employment Discussed at Ohio State

Meeting in the chemistry building, Ohio State Branch heard M. M. Boring of the General Electric Company speak on "The Problem of Employment" in which he pointed out the importance of personality to the graduate engineer and the features in him which prospective employers require.

Oklahoma A. & M. Branch members at a joint dinner meeting with Pi Tau Sigma, were introduced by J. H. Engelbrecht, secretary of the Mid-Continent Section, A.S.M.E., to F. W. Robson, engineer for the Carter Oil Company, who talked on "Engineering in Oil." Ten members are making plans to attend the student-group meeting at College Station, Texas.

Penn State Has Lecture and Demonstration

A demonstration and a lecture were presented by F. C. Stewart, member, A.S.M.E., and professor of mechanical engineering, before 75 members of Penn State Branch. He traced the origin and development of power from the origin of man through the early steam engine, James Watt, Street, Otto, Langen, Beau de Rochas, and Diesel, to the present day. By the use of a glass tube, Professor Stewart demonstrated flame travel and rate of burning with different air-fuel ratios and with detonation. Using a tin can and a perfume-bottle spray, he demonstrated the firing and explosion of various air-fuel-ratio mixtures.

Pratt Branch members visited the 14th Street power plant of the Consolidated Edison Company in New York. The inspection was especially interesting to students studying power-plant design. Covering the use of the psychrometric chart and various air-conditioning controls, W. A. Canney, engineer in charge of designing the air-conditioning system for Radio City, at the monthly meeting spoke on air conditioning in the home.

Purdue Has 300 at Meeting

With 75 members and 225 guests crowded into the E.E. building, Purdue Branch presented James Aston, member, A.S.M.E., and consulting metallurgist, who gave a talk on the wrought-iron manufacturing process to which he lends his name. The lecture was followed by a motion picture describing the process.

Harte Cooke at Rensselaer

Rensselaer Poly Branch has purchased a large banner with the A.S.M.E. seal and letters for display outside the mechanical-engineering building on meeting days. This banner was first used when Harte Cooke, vice-president, A.S.M.E., and R.P.I. graduate of 1892, arrived to give a talk on Diesel engines. The major portion of the presentation was an explanation of slides showing commerical installations of Diesels in all parts of the United States. This meeting was one of the best attended with 55 members and 30 guests present.

Stanford Branch heard Professor Gullickson list the many prizes which will be presented to winners at the student group meeting in Los Angeles.

Syracuse Goes Ice Skating

An ice-skating party was held by the Syracuse Branch at the Coliseum. Needless to say, the embryo engineers had an enjoyable time, thanks to K. R. Davenport, chairman in charge of the affair. A new type of speed governor was described by Robert Gehring and the art of diemaking, illustrated with a set of razor parts made by this process, was discussed

ON THE BUCHANAN DAM INSPECTION TRIP, TEXAS STUDENT BRANCH

(From left to right: A. J. Cohen, vice-chairman, Mr. Barton, electrical supervisor of the Dam, L. T. Wright, secretary, H. G. Walcott, chairman.)

by Robert Guiendon at one of the branch meetings. An earlier meeting featured E. Bouton talking on photographic filters and Lee Castle speaking on the factors which affect the buying of all grades of coal.

TEXAS TECH members ought to know all about the carbon-black industry by now. For the second time this school year, Max Nuttal gave a talk on this subject with which he is familiar, having worked in one of the Texas plants the last five summers.

Texas Makes Dam Inspection

The members of TEXAS BRANCH went on an inspection trip to the Buchanan Dam which is being built on the Colorado River about 75 miles northwest of Austin. Chairmen of the various committees for this term are: program, C. L. Crockett; social, J. T. Morris; membership, E. J. Wacker; and publicity, J. C. Hight. Through the efforts of these boys and their committee members, President Davis was royally welcomed to the campus.

TORONTO BRANCH was able to visit the Ontario Research Foundation laboratories through the kindness of O. W. Ellis, member, A.S.M.E., and director of the Foundation.

Tulane to Award A.S.M.E. Keys

Taking a regular A.S.M.E. student watch charm and mounting it on a gold-plated silver key blank, the members of TULANE BRANCH prepared three keys which will be awarded as first prizes to the sophomore, junior, and senior student members who present the best papers in their class at a contest sponsored by the branch. The second and third prizes in each group will be donated by local engineering firms. An all-day inspection trip was made by the branch members to a local sulphur plant where they were able to view the process of sulphur extraction from beginning to end. At a meeting, W. B. Gregory, member, A.S.M.E., and professor of mechanical engineering, delivered an illustrated talk on rice irrigation in Texas.

UTAH BRANCH members were shown the film entitled, "Heat and Its Control."

VANDERBILT BRANCH had T. M. Pettey read a paper on "Fuel Injection in the Spark-Ignition Engine." At a meeting sponsored by the branch and attended by 25 members and 100 guests, O. W. Eshbach of the American Telephone and Telegraph Co., spoke on the "Problems of Communication."

History of Lathes Given at Vermont

F. T. Gear, chairman of the VERMONT BRANCH, gave a talk on "Lathes, Old and New." Since Fred worked for the Jones and Lamson Machine Tool Co. last summer, much of his talk was based on his observations and experience. A visit to a dye plant was arranged by F. H. Canary, vice-chairman.

VIRGINIA BRANCH members inspected the Charlottesville yards of the C. & O. R.R., where they were given a ride from the turntable into the roundhouse on the latest-type passenger locomotive. The members heard an informative lecture on "Jefferson the Scientist," by Dean Walter S. Rodman, at a branch meeting.

WASHINGTON BRANCH has Bob Henderson working on a series of exhibits to be shown during the student-group meeting in April.

Automatic Welding Discussed

Presenting a talk together with a film on the subject of automatic welding, C. I. MacGuffie, General Electric Co., explained to the members of GEORGE WASHINGTON BRANCH the principles of electric welding and its many uses. Prior to the talk B. M. Randall suggested a trip to the Bureau of Standards.

YALE BRANCH had talks presented by B. L. Hutchinson on modern air cooling and conditioning, W. Gray on the modern construction of buildings, and D. Irwin on the development of copper mines in southern Rhodesia. On the fifth and sixth of March, the branch presented several interesting displays in connection with engineering exhibit which is held annually.

Corresponding Secretaries Please Note

The May issue of MECHANICAL ENGINEERING, which will contain the last Student Branch News for this school term, is going to press on April 6, 1938. All reports and news items from corresponding secretaries for inclusion in this issue must be in the hands of the editor on or before that date.

Tips on '37 Graduates

SENIOR student members are already looking for jobs into which they can step upon graduation this June. Some have already been placed, while others are still hunting for suitable positions.

Mechanical-engineering graduates are more fortunate than other engineering students because of the many positions to which they are adaptable. To give student members an idea of the opportunities open for them, an analysis has been made of about 600 questionnaire cards returned by officials of 60 colleges throughout the country out of approximately 1000 sent out by the Society in March, 1938, asking for follow-up information about June, 1937, graduates.

Taking 100 graduates as a base, 46 are employed with manufacturing firms, including such industries as air conditioning, steel, steam equipment, automotive, farm equipment, and electrical apparatus. Seven of the 46 boys are taking the G.E. training course.

Seven boys have become connected in various capacities with oil companies, two are working for public utilities, one is with the telephone company, three are doing mechanical-engineering work in the chemical industry, and three are in aviation. One of the boys is in government service, possibly down at Randolph Field in Texas learning to become a flier. From reports given out by the War Department, the army is experiencing difficulty in obtaining enough college graduates to take the course. Further information may be obtained from Washington, D. C.

Four of the boys have stayed in school and are taking graduate courses. Seven are in miscellaneous work such as mining, meat packing, cork fabrication, construction, retailing, rubber manufacture, typewriter assembly, lumbering, and law. Only three out of the 100 have indicated definite unemployment. Due to the inability of the colleges to supply full information, the employment status of 26 boys is questionable. Among the returns was one telling about a graduate working for a public utility firm who was so dissatisfied, that he was seriously thinking of studying for the ministry.

As a further aid to A.S.M.E. student members, there is the Engineering Societies Employment Service with offices at 31 West 39th St., New York, N. Y.; 211 West Wacker Drive, Chicago, Ill.; and 57 Post St., San Francisco, Calif. Students desiring to use the service should request an application for registration from the nearest office or from the headquarters of the A.S.M.E. A weekly bulletin, listing the positions available, is now being sent to the honorary chairman of each student branch for the use of the student members.

Connecticut State College to Train Apprentices

A NEW PLAN of engineering extension training for apprentices now employed in the aircraft factory was recently announced by Connecticut State College and the Pratt & Whitney Aircraft Co. Under the terms of this plan, the apprentices will receive, in addition to their factory training, at least six hours of instruction each week in college engineering subjects, with the object of fitting them for supervisory and executive positions in the factory. According to the announcement, this is said to be the first example of this kind of extension work in engineering education to be undertaken by any accredited college in Connecticut, and perhaps in the entire United States. It is similar to the extension courses and assistance now offered in agriculture by state colleges.

Other Engineering Activities

Nontechnical Phases of Engineering Discussed in E.C.P.D. Report

Progress of Council's Committees Reviewed

NOTING the trend in the extension of engineering far afield from old-time technical confines, Charles F. Scott, chairman of the Engineers' Council for Professional Development, in the fifth annual report of that body, now available for public distribution, predicts a future which will call more and more upon the engineer for aid in solving its accumulating nontechnical problems. Traditionally technical through the centuries the engineer has been slow in assuming this new role. Accustomed to dealing with definite data and rigid physical laws, the less definite situations in economic and social relations do not appeal to the majority of present-day engineers.

"Engineering Method" of Approach

The real contribution of engineering to nontechnical fields is the "engineering method" of scientific approach for the solution of economic and social problems. Furthermore, the public does not understand the significance of technological changes in producing the more abundant life, nor does it appreciate that the achievements of the engineer are products of a scientific method, which may result in achievements in other fields as well.

It is felt that the work of better acquainting the young engineer with the nontechnical phases of engineering may well be given emphasis by the Engineers' Council for Professional Development, which is a conference of engineering bodies organized to enhance the professional status of the engineer through the cooperative support of those national organizations directly representing the professional, technical, educational, and legislative phases of an engineer's life. The participating bodies are the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education, and the National Council of State Boards of Engineering Examiners.

Developing a system whereby the progress of the young engineer toward professional standing can be recognized by the public, by the profession, and by the man himself, the Council through standing committees on student selection and guidance, accrediting (approval) of engineering curricula, professional training, and professional recognition, aims to coordinate and promote efforts and aspirations directed toward higher professional standards of education and practice, greater solidarity of the profession, and greater effectiveness in dealing with technical, social, and economic problems.

The work of the Council in accrediting engineering curricula is monumental; in no other profession has the inspection of curricula and courses been carried out in so orderly a fashion and with so much expedition; in selection of freshmen there was no precedent to follow—other professions draw men directly from the colleges while the engineering profession draws its students from high schools. To cull some 20,000 prospective engineering freshmen from hundreds of thousands of seniors, in thousands of high schools, for entrance to 150 engineering schools, is a mighty task. Upon it, however, depends the careers of individuals, the efficacy of engineering schools, the quality of the engineering profession, and its contribution to the interests of the general public.

Since the accrediting program was inaugurated in 1935, a total of 134 degree-granting engineering schools have submitted 645 curricula for accrediting. Of this number 129 institutions have been visited to date and recommendations prepared on 626 curricula as follows: To accredit 374; to accredit provisionally for a limited period, 71; to defer action, 8; and not to accredit, 173. At present there is every indication that the accrediting program will result not only in a generally accepted accredited list, for which there is a real need, but also in a definite stimulation to higher excellence in our engineering schools, and a wide distribution among the institutions, particularly among the officers of administration, of some of the best ideas in engineering education.

Crux of Situation in Training Juniors

The crux of the entire program of professional training lies in the development of training material for Junior engineers and in the formation of Junior Groups. While it is conceded that the immediate focus of interest of the Junior engineer is his job, the Council feels that very serious consideration must be given to the long-range task of developing professional engineers in the broadest sense of the term. The assistance on problems of the job is definitely a responsibility of the local sections of the national societies. A tangible measure of assistance can be given by the local groups of engineers in acquainting the Juniors with the provisions of the licensing law of their particular state and in organizing means of preparing qualified individuals to pass examinations or otherwise meeting the legal requirements.

The present main objective of the E.C.P.D. is the development of the young engineer for his subsequent career. In his choice of engineering and in the schools of learning and of experience there should be proper balance of the technical and nontechnical. It is of first importance to get engineering in true perspective in relation to life in general, so that the development of the individual may be well-balanced.

As he visions the larger goal the youth may realize his need for a broad preparation, both technical and liberal, for mastering principles as well as developing skills, for acquiring a method as well as to think and to deal with men as well as with things, for preparing to be a leader in the future by being a leader now, for sensing the changing function of his profession in our changing world and cultivating attitudes which differentiate the engineer-manager, the engineer-administrator and the engineer-citizen from the purely technical engineer.

Flanders and Compton Will Talk at Management Congress

MANAGEMENT'S difficulties with and responsibilities to government; the true relationship of "security" and "social control" to incentive and free enterprise; the social implications of the advancement of science; the case for labor, for management, and for the consuming public in the troubled inter-relations of the three—all these will be discussed, perhaps more fully than on any previous occasion, at the seventh International Management Congress, in Washington, beginning September 19, 1938.

Ralph E. Flanders, past-president of the A.S.M.E., is to speak at a public session on "The Balancing of Incentive and Social Security." Dr. Karl T Compton, member, A.S.M.E.,

Courtesy St. Louis Convention Bureau

A GLIMPSE OF THE MISSOURI BOTANICAL GARDEN AT ST. LOUIS, WHERE THE A.S.M.E SEMI-ANNUAL MEETING IS TO BE HELD JUNE 20–24

and president of Massachusetts Institute of Technology, will discuss "The Influence of Technological Progress on Social Development." Oswald W. Knauth, president of the Associated Dry Goods Corp., speaks on "Reshaping Distribution to Modern Economy."

Two of the most forthright and provocative addresses of the sessions are hoped for on "The Continuance of Free Enterprise." One is to be delivered by an American; the other by a Czechoslovakian. To give added point to this latter address, it will be given at the same session with an address from Germany on "Social Aspects of Rationalization," and one from Italy on "Employee Security as a Responsibility of the State."

One entire session will be devoted to a three-way discussion of the labor problem by an internationally known labor-union executive, a large employer, and a representative of the general public who also, it is hoped, will be a man of wide experience and the highest reputation.

The distinction is being carefully preserved between the "technical" and the "general" or public sessions of the Congress. In the general sessions there will be no discussion, but a series of direct addresses by men of international fame (including a reputation for not being afraid to say things that need saying). The technical sessions, on the other hand, will be devoted wholly to free discussion from all viewpoints of the papers previously submitted, printed and distributed to the Congress delegates.

"Case histories" are to predominate at the technical sessions, the papers submitted reveal. But they are case histories submitted in terms of their bearing upon management problems still needing solution; upon the struggle for efficiency and economy in the operation of public services and Government departments; upon the essential information required by management, and how it is to be obtained and organized for effective use; upon the proper training of executive personnel; and more directly and specifically than in the general sessions, upon the whole problem of labor relations.

As a result, Congress delegates will be presented with virtually a complete review of the best thought of the entire business and industrial world, upon every specific problem or aspect of management. Why business must, and how it can, find both a voice in which to state its own case, and an audience which will listen; the process of industry from purchase through manufacture, advertising and sale; personnel problems from every angle; each of these and a score of other topics will be presented and discussed by the world's best authorities on that subject.

Mid-West Power Conference With Broad Program Opens April 13 in Chicago

P. W. Swain and C. F. Hirshfield to Present Main Papers

OPENING April 13 and continuing for three days, the Mid-West Power Conference, under the sponsorship of Armour Institute of Technology, Iowa State College, Purdue University, State University of Iowa, University of Illinois, University of Michigan, University of Wisconsin, Chicago Section, A.S.M.E., and other local and national engineering societies, will meet in Chicago with headquarters at the La Salle Hotel.

Reorganized under academic sponsorship, this conference will be open to all persons interested in the solution of the country's power problems. Arrangements have been made to provide the freest possible discussion of the technical, economic, and social implications of power usage. The committee has tried to make the conference of wide interest both to engineers and to power producers, distributors, and consumers.

Addresses at Opening Session

An address of great general interest on the "Social Significance of Power Progress" at the opening session will be presented by P. W. Swain, member, A.S.M.E., and editor of *Power*. A companion paper on "Trends of Research in the Power Industry," by C. F. Hirshfeld, member, A.S.M.E., and chief of research of the Detroit Edison Company, will describe probable future technical progress.

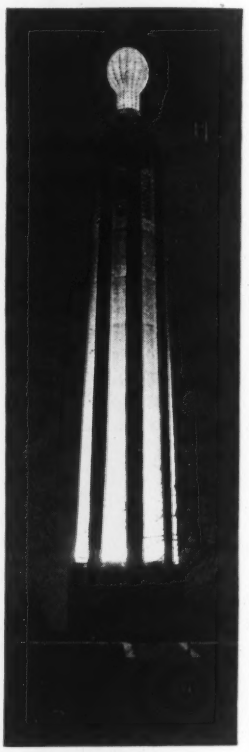
A group of technical conferences will follow the opening session. Wednesday afternoon, April 13, will be devoted to three conferences on (1) fuels, (2) trends in electric power equipment, and (3) locomotive power units. The conferences on Thursday morning, April 14, will include (1) developments in stationary power plants, (2) power measurements, and (3) valuation of power plants. The afternoon will be devoted to a study of (1) metals, (2) problems in the operation of power plants, and (3) water power.

Special Trip to Armour Institute

The special program arranged for Friday, April 15, includes an inspection trip to Armour Institute of Technology where papers on "Heat Energy Costs of Btu Auditing," by H. O. Croft, member, A.S.M.E., and "Power Requirements for Residential Air Conditioning," by A. P. Kratz, member, A.S.M.E., will be presented. This will be followed by an inspection of the high-pressure laboratory where Dr. T. C. Poulter has reached the record-breaking pressure of one and one-half million pounds per square inch. After luncheon on the campus, the group will be transported to the Carnegie-Illinois Company plant where a new power installation and new steel-manufacturing equipment will be inspected.

Complete information can be obtained by addressing the conference director, L. E. Grinter, dean of the graduate division, Armour Institute of Technology, Chicago, Illinois.

Edison Memorial Tower Is Dedicated



EVENING VIEW OF EDISON MEMORIAL TOWER

AS a fitting commemoration of the 19st anniversary of the birth of Thomas Alva Edison, honorary member, A.S.M.E., a tower topped with a giant replica of the first practical incandescent lamp was dedicated at Menlo Park, N. J., on Feb. 11, 1938. The edifice, which is 131 ft high and known as the Edison Memorial Tower, was presented by William S. Barstow, president of the Thomas Alva Edison Foundation, Inc., to the foundation in behalf of the Edison Pioneers, of which he is honorary president. The replica of the lamp was first lighted when a button was pushed at the annual luncheon of the Edison Pioneers, held the same day in New York City.

The tower was built as a lasting reminder of the many achievements of Edison at Menlo Park during the period from 1876 to 1886, and replaces the temporary steel structure that was erected in 1929 to mark the spot where the first practical incandescent lamp was developed on Oct. 21, 1879. A perpetual light, fed by current from various sources to guard against failure of any one and burning since Oct. 21, 1929, when it was switched on by Edison from Dearborn, Mich., has been incorporated in an enclosure of black granite set in the base of the tower. A bronze door with plate glass in one of the sides of the octagonal base permits a view of the "Eternal Light" room; on each of the other seven sides is a bronze tablet describing inventions made by Edison at Menlo Park.

Precast buff concrete slabs form the face of the tower, growing lighter in color toward the top where a light-blue shading provides an effective contrast with a glass bulb almost 14 ft high and 9 ft in diameter at the widest part, and containing 153 pieces of amber-tinted Pyrex glass two inches thick. In the daytime, the glass will produce a sparkling effect under the sun, and in the evening, will be illuminated by three sets of light bulbs totaling 5200 watts. Commemorative of Edison's invention in 1877 of the phonograph, the tower

is also equipped with a modern sound system containing two sets of loud-speakers, one group just above the base and a second group 96 ft above the ground.

Foundrymen to Hold Meeting, Cleveland May 16–19, 1938

MEETING in Cleveland, the forty-second annual convention of the American Foundrymen's Association will open Monday morning, May 16, and continue to Thursday, May 19, with the Foundry Show opened in advance for inspection on Saturday, May 14. The meetings and exhibits will be held in the rooms and exhibit halls connected with the Cleveland Public Auditorium.

Comprehensive Program

The program of meetings includes 35 sessions comprising management, technical, production, and shop-practice meetings and round-table conferences relating to steel, malleable, nonferrous, and gray-iron foundry practices. Every phase of foundry technique and operating practice is expected to be covered.

A series of management sessions will feature speakers on apprentice and foreman training, foundry safety and hygiene, melting costs, job evaluation, and time study. General-interest technical sessions listed, are on foundry refractories, sand research and control, pattern making, and material handling. The meetings of individual interest to gray-iron and nonferrous foundrymen are being arranged for the first two days, those for the steel foundrymen the second and third days, and for the malleable foundrymen the third and fourth days.

Officers Nominated by Foundrymen

Meeting in Chicago, Feb. 10, 1938, the nominating committee of the American Foundrymen's Association designated the following officers and directors: For president, Marshall Post; for vice-president, H. S. Washburn; for directors, H. Bornstein, F. A. Lorenz, Jr., D. O. Thomas, H. S. Hersey, and G. A. Seyler, member, A.S.M.E.

A.S.M.E. Members Invited by N.Y.U. to Free Lectures

IN ACCORDANCE with its policy of presenting occasional lectures by prominent engineers on topics of major interest, the College of Engineering of New York University invites A.S.M.E. members and their friends to attend the free lectures presented on the following dates in the Green Room, East Building, 239 Greene Street, Washington Square, New York City.

On Wednesday evening, April 20, 1938, at 8:30 o'clock, E. F. W. Alexanderson, consulting engineer, General Electric Company, will present an illustrated lecture dealing largely with thyraton tubes and their uses for such purposes as speed variation and control of electric motors, frequency changers, nonsynchronous a-c power transmission, and d-c power transmission. The design of thyraton tubes as well as the methods for their use are still in the early stages of development, but it is expected that electronics will play an important part in engineering of the future.

The design of the World's Fair will be discussed by Robert D. Kohn, president of the Council of Registered Architects in the State of New York, Wednesday evening, May 4, 1938, at 8:30 o'clock. The subject will be treated from the point of view of the social significance of the form in relation to the purpose; the physical structure being considered as the direct result of the kind of social program which a fair such as the New York World's Fair of 1939 is intended to encourage and help to develop.

Human-Engineering Lectures Given by Johnson O'Connor

A SERIES of six lectures on human engineering has been given by Prof. Johnson O'Connor of Stevens Institute of Technology, every Thursday evening, beginning Feb. 24, at the New School for Social Research in New York City. A brief outline of each lecture is hereby presented to show how Professor O'Connor attempted to give each person present an inventory of his or her characteristics which would help one in fulfilling the duties of an executive or assist in seeking a position and advancement.

1 *The Measurement of Aptitudes.* The conception of the human-engineering laboratory at Stevens. Some early experiments. A description of the ten aptitudes which can now be measured: Finger dexterity, accounting aptitude, structural visualization, tweezer dexterity, inductive reasoning, creative imagination, visual memory, observation, personality, and tonal memory.

2 *Difficulties Encountered by the Too-Gifted Person.* School difficulties encountered by the too-many-aptitude student. Lack of early effort. Lack of incentive. Restlessness. Seeking a problem rather than a job. Some of the problems which are facing the world.

3 *Personality.* Differences between the objective and subjective person. Personality and sales work. Personality and executive work. Growth of personality with age. Can personality be changed? Sex differences. The subjective person who acts objectively. Behavior?

4 *Industrial Testing.* The reduction of labor turnover. The effect of testing on accidents. Reduction in training time. Training as an industrial problem. Reduction in complaints from customers.

5 *English Vocabulary.* The measurement of English vocabulary. Its growth with schooling. Its importance in executive success. The importance of a laboriously acquired vocabulary. The three laws of learning vocabulary which underlie the construction of the Johnson O'Connor English vocabulary building plan.

6 *The Future of Human Engineering.*

Montefiore Foundation Offers Triennial Award

April 30, Closing Date for Entries

A PRIZE of 18,000 Belgian francs (about $600), constituting interest on a fund of 150,000 francs established by George Montefiore and administered by a foundation bearing his name, will be awarded again this year for the best original work presented on scientific advancement and progress in technical application of electricity in any field. The award is distributed triennially and the closing date for entries in the present contest is April 30, 1938.

The competition is limited to works presented during the three years that immediately preceded the meeting of the jury of award. Papers either signed or anonymous are acceptable if typewritten or printed and must be in both French and English. It is necessary to submit twelve copies. By a four-fifths vote of the jury of award, composed of five Belgian and five foreign electrical engineers, one third of the award may be given to a person who has not taken part in the competition, or to a work which, though not completely meeting the contest regulations, discloses a new idea that may have an important relation to the electrical field.

Further information of this and the next contest may be obtained from L. Calmeau, the general secretary of the foundation, who may be reached at the headquarters of the Association des Ingénieurs Électriciens, 31 Rue Saint-Gilles, Liege, Belgium.

N. Y. Safety Council Has 41 Sessions Scheduled for Convention

MEMBERS of the A.S.M.E. are invited by The Greater New York Safety Council and the fifty-eight cooperating agencies to be present and participate in the 41 sessions of the ninth annual convention to be held at the Hotel Astor in New York City, April 19–21, 1938. According to the convention committee, the sessions are designed to extend the knowledge of safety so that there may develop a broader and deeper science in the prevention of accidents in all places where men foregather—in the home, on the streets and highways or at work, on land or sea or in the air.

Sessions which should prove of interest to A.S.M.E. members include the aeronautical meeting of which Alexander Klemin, member, A.S.M.E., is presiding officer and Jerome Lederer, member, A.S.M.E., secretary; the conference on elevator safety; the discussion of accident problems in the small plant; the session on materials handling, Walter S. Paine, member, A.S.M.E., chairman; and the meeting on boilers and pressure vessels, Alex W. Luce, member, A.S.M.E., chairman. In conjunction with the convention, an exhibit of safety equipment and appliances will be shown by 60 manufacturers and insurance companies.

A.S.T.M. Holds Symposium on Plastics

A SYMPOSIUM on plastics was the technical feature of the 1938 American Society for Testing Materials regional meeting held in Rochester, N. Y., March 9, 1938.

Six technical papers covering the properties, testing, measurement of thermal qualities and flow relations, hardness characteristics, and permanence of plastics were presented and evoked much discussion.

Lubrication and Lubricants

AMERICAN engineers will be interested to know that The American Society of Mechanical Engineers has obtained permission from The Institution of Mechanical Engineers to publish an American edition of the Proceedings of the General Discussion of Lubrication and Lubricants.

This General Discussion was organized by the Institution with the cooperation of 53 scientific and engineering bodies, and was held last October for the purpose of reviewing the present state of the science and the practice of lubrication in order to correlate theory and practice, to show the applications of bearing design, to relate pure research with commercial practice, to obtain current views upon bearing metals, and to bring out the significance of laboratory tests. From these data of leading experts throughout the world have been selected for inclusion in the Proceedings of the General Discussion on Lubrication and Lubricants, the 75 articles together with discussions.

The book will be published in May. Price $6.50. Requests should be sent to publication-sales department, The American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y.

Wisconsin Offers Home-Study Course in Hydraulics

KEEPING ENGINEERS up to date in their profession without any loss of time from their business, is now possible through a new and revised home-study course in hydraulics offered by the extension division of the University of Wisconsin, Madison, Wis. The course teaches the fundamental theory of hydraulics, including the flow of fluids in pipes and open channels, the various devices used to measure flowing fluids, and the pressure of fluids on submerged surfaces.

Oil-Burner Home-Study Course Offered by Rutgers

TO ROUND out its home-study courses in the field of heating and ventilating, Rutgers University is now offering a course in oil-burner engineering in fifteen sections or lesson assignments. Also available are the newly revised air-conditioning course and one in heating and ventilating. Full details may be obtained by addressing the Rutgers University Extension Division at New Brunswick, N. J.

Men and Positions Available

Engineering Societies Employment Service

MEN AVAILABLE

DEAN OF ENGINEERING OR HEAD DEPARTMENT OF MECHANICAL ENGINEERING. Wide teaching and administrative experience as head of department of mechanical engineering. Specialty: Theoretical and applied engineering thermodynamics. M.S. Cornell University. Me-36.

GRADUATE MECHANICAL ENGINEER, age 24. Eighteen months' experience in laboratory of air-conditioning manufacturer. Now employed, desires new position to learn sales engineering in air-conditioning or refrigeration industry. Me-37.

MECHANICAL ENGINEER; graduate B.S. in '36 now working for M.S. degree. Available for position with oil refinery or refinery construction company; 2 years' experience in refinery operation and one year drafting experience. Me-38.

MECHANICAL-ELECTRICAL ENGINEER; graduate Drexel Institute; American; age 40; married; 18 years' experience in power plant, chemical plant, electrical design, construction, and maintenance. Plant engineer for last 10 years. Me-39.

POWER PLANT ENGINEER; 32. Ten years' experience in operation, maintenance, and supervision of industrial and utility power plants; 6 years chief engineer of industrial power plant. Willing to go anywhere. Me-40.

JUNIOR M. E. Experience in Diesel and gas engines, electric and steam-driven air compressors. Graduate Syracuse '36. Desires responsible position in engine field. Location East or Central. Me-41.

EXECUTIVE. Factory or general manager; Cornell M.E. 1913; experienced in every phase of factory activities covering interchangeable parts manufacturing, woodworking, and plastics; 5 years spent installing Point or Bedaux system. Me-42.

CORNELL M.E. GRADUATE, 25 years' varied experience as manufacturing executive and designing engineer, electrical and metal working, would like position as executive engineer, particularly interested redesigning or reprocessing for economy. Me-43.

MECHANICAL ENGINEER, recent graduate. Honor student with scholastic record over 90 per cent. Excellent character and personality. Prefers work in machine or automotive design, or research in this field. Member A.S.M.E. Me-44.

MECHANICAL ENGINEER AND DRAFTSMAN, age 22; 1936 graduate; experience in bulk oil plant construction, design and field, and in design of all types weighing scales. Me-45.

MECHANICAL ENGINEER, interested production engineering; 3½ years' experience, production control, plant layout, machine shop, time study; 1 year production manager—mass

(*Continued on page 364*)

Oil-Metering Technological Conference, April 7–8

SPONSORED by the Petroleum Division of the A.S.M.E., an Oil-Metering Technological Conference will be held at the University of Oklahoma, Norman, Okla., April 7 and 8. The purpose of the conference is to provide through the cooperation of the University of Oklahoma, the Fluid Meters Subcommittee of the Society, the various branches of the petroleum industry, and the manufacturers of metering equipment, a means whereby men in the industry may get together to study problems pertaining to metering the flow of petroleum and its products.

Papers of an instructional nature which are pertinent to the subject of oil metering will be presented for discussion. Definite periods will be allotted for the presentation of papers on research, pipe lines, production, and refining.

Missouri School of Mines Engineers' Business Meeting

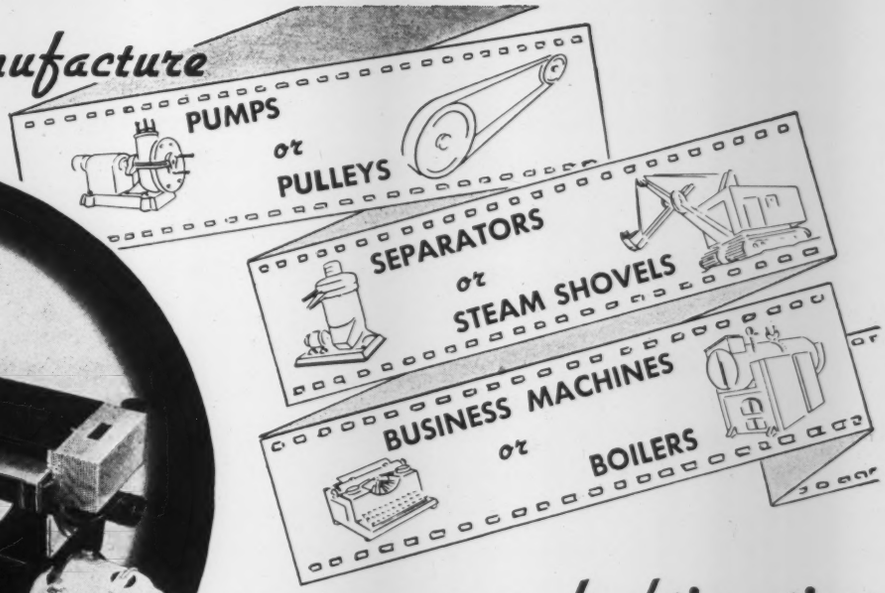
AN INSTITUTE of Business and Industrial Relations is to be held by the Missouri School of Mines and Metallurgy at Rolla, Missouri, April 8–9, 1938. Though the institute is held primarily for the senior students of the school, members of the A.S.M.E. are cordially invited to be present at the sessions.

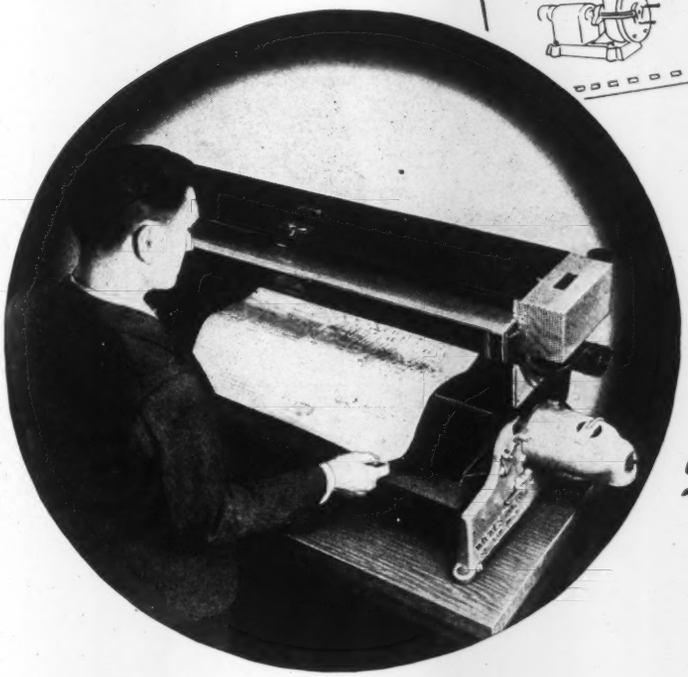
Bureau of Mines Lectures at University of Maryland

UNDER the auspices of the University of Maryland, the Bureau of Mines of the U. S. Department of the Interior, which maintains its Eastern Experiment Station on the campus at College Park, will offer an interesting series of public lectures in the auditorium of the College of Engineering. The lectures will be given throughout the university year on the fourth Tuesday evening of each month beginning at 8:15.

On March 22, A. C. Fieldner spoke on "Fuels of Today and Tomorrow." "Boiler Water, the Treatment of Feedwater for a Modern High-Pressure Boiler," will be the subject of the paper presented by W. C. Schroeder on April 26. R. S. Dean will discuss "Mineral Physics" on May 24. There is no charge for admission and A.S.M.E. members are cordially invited to attend.

Whether you manufacture





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Although the Ozalid Process is the simplest and fastest method of making prints ever developed, savings are not limited merely to the time of making prints, but, in designing and engineering, actually *begin on the drafting board!*

These savings are effected through the use of Ozalid Transparent Duplicates . . . sensitized translucent papers and cloths by which any drawing, tracing, typewriting or written data can be reproduced quickly and economically in the two simple steps of exposure and dry-development.

These true-to-scale duplicates provide unprecedented short-cuts in drafting practices. For example, draftsmen can save hours and hours of tedious labor by preparing but one tracing that is standard for all plans with the exception of details and dimensions, and adding alterations to an Ozalid Transparent Duplicate of the master tracing, to secure a new original, without defacing the master tracing or redrawing standard design.

Even extensive changes in preliminary designs or plans can be made effectively and economically. First make an Ozalid Print of the original drawing. On this print, remove all unwanted detail by means of a simple eradicator fluid, and then make an Ozalid Transparent Duplicate, upon which all changes can be added to the parts of the drawing which have been retained.

These and other savings in drafting time are often sufficient to equal if not exceed the moderate cost of Ozalid Equipment the first few months. When combined with such other advantages as cleanliness, simplicity, speed and compactness of the process, and the easy-to-read, true-to-scale features of the prints, they make the Ozalid installation a decidedly profitable investment.

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production sheet-metal stampings. Able to handle people. Exceptional references. Me-46.

CHIEF ENGINEER, seeks responsible position with manufacturer gas, gasoline, Diesel engines, compressors, other machinery. Many years technical and executive experience these fields. Particularly interested new developments. Inventive ability. M.E. degree. Me-47.

WATER SUPPLY, SEWAGE-DISPOSAL ENGINEER, Massachusetts Institute of Technology graduate, licensed professional engineer in New York and New Jersey, having broad experience in investigation, evaluation, design, construction, maintenance, and operation. Me-48.

MECHANICAL ENGINEER; age 35, seeks position with tar or oil refinery or roofing plant; 6 years' experience as plant engineer in charge of maintenance, construction, and operation of tar refinery and roofing plant. Me-49.

ENGINEER AND DRAFTSMAN experienced in patent matters, member A.S.M.E.; 10 years' conventional drafting-room experience prior registration patent office; seeks association with manufacturer to handle applications, drawings, or related work. Me-51.

EXECUTIVE, M.E. degree. Over 10 years' experience in catalog preparation, publication, and distribution. Organizer. Purchasing and traffic of basic materials. Wide knowledge of engineering and architectural materials. Me-52.

POSITIONS OPEN

PRODUCTION MANAGER, mechanical engineer with at least 5 years' production experience in manufacture of tile or wallboard. Apply by letter. Location, New York, N. Y. Y-2733.

TOOLROOM FOREMAN for toolroom with 40 men, up-to-date equipment. Must be thoroughly experienced in designing and making of first-class high-precision tools for manufacture of a large variety of small and accurate parts. Only person who has worked in similar capacity and has thorough knowledge of work outlined will be considered. Apply by letter giving full information. Location, California. Y-2737CS.

MECHANICAL ENGINEERS with several years' experience in design and construction of shipyards. Several draftsmen will also be required. Apply by letter. Location, East. Y-2738a.

PURCHASING ENGINEER, mechanical or electrical, with experience in purchase of materials and equipment; experience preferably for shipyards. Apply by letter. Location, East. Y-2739.

MECHANICAL ENGINEER with thorough knowledge of shell and tube apparatus, preferably from heat-transfer and construction and manufacturing phases. Essential that he be thoroughly grounded in design, construction, and manufacturing. Work will be in connection with condensers, water coolers, etc. Must have specialized in this line of equipment. Apply by letter. Location, Pennsylvania. Y-2741.

SALESMAN with knowledge of foundry practice such as making castings, etc. Company sells steel castings, malleable iron, gray-iron and alloy-metal castings. Must own car. Apply by letter. Resident of Connecticut preferred. Y-2743.

CONSULTING ENGINEER, mechanical, with experience in manufacturing process and equipment necessary to fabricate rock wool. Apply by letter. Location, South. Y-2746.

RECENT GRADUATE MECHANICAL ENGINEER who has majored in mechanics. Work will cover research in building materials and physical tests in connection with development of new construction types. Apply by letter. Location, Middle-West. Y-2747C.

MECHANICAL ENGINEER, young, with several years' experience in development work involving design of semiworks and full-scale process equipment. Textile or paper experience desirable. Apply by letter stating salary. Location, Minnesota. Y-2758-R-594C.

DESIGNERS with experience in designing various instruments such as aircraft instruments, pressure and vacuum gages, industrial instruments, etc. Engineers with actual experience in designing aircraft instruments preferred. Apply by letter. Location, East. Y-2763.

PRODUCTION ENGINEER to act as contact man between engineering department and shop of company manufacturing aircraft instruments, pressure and vacuum gages, etc. Must be able to establish right procedure for production, advise in regard to tools and see that shop follows instructions issued by engineering department. Apply by letter. Location, East. Y-2764.

TERMINAL SUPERINTENDENT, mechanical engineer. Should understand machinery, trucks, tractors, and miscellaneous equipment. Must be familiar with welding, and have experience in steel boat and barge construction, and repair work. Capable of making work estimates. Knowledge of Spanish essential. Apply by letter. Location, South America. Y-2766-R-7166S.

METHODS ENGINEER with experience in laying out work to be done in machine shops and toolrooms for establishing standard practice methods from which time studies may be made. Must have experience in machine-shop and toolroom practice, and be able to lay out work, direct studies, and instruct two or three rate setters in duties. Apply by letter. Location, Massachusetts. Y-2774.

GRADUATE MECHANICAL OR INDUSTRIAL ENGINEER, 35–50, with a number of years' experience as industrial safety engineer for paper and pulp-mill safety work. Experience with insurance company would also be desirable. Salary, $60 a week. Apply by letter. Location, South. Y-2781.

MECHANICAL OR INDUSTRIAL ENGINEER, 35–50, with minimum of 5 years' experience in purchasing machinery and metals. Export experience desirable. Perfect knowledge of technical Spanish essential. Apply by letter. Location, New York, N. Y. Y-2783.

INSTRUCTOR OR ASSISTANT PROFESSOR of mechanical engineering, 20–34. Duties will be half time as mechanician to build or install apparatus such as meteorological instruments, hydraulic-laboratory equipment, aeronautical-laboratory equipment, chemical-laboratory equipment, etc., and half time as instructor, probably in university machine shops. Must have several years' experience in repair or production of fine instruments or development work of small apparatus requiring precision work. Teaching experience not essential, but desirable. Salary, $1800–$2400 for nine months' work. Apply by letter. Location, South. Y-2788.

Local Sections

Coming Meetings

Baltimore: April 7. Engineers' Club of Baltimore, 6 West Fayette St., Baltimore, Md., at 8:15 p.m. Subject: "Railroading with Modern Power," by W. M. Guynes, assistant engineer, transportation department; manager, locomotive and electrification section, General Electric Company. This will be an illustrated lecture with slides and sound film showing the comparative operating characteristics of reciprocating steam locomotives, Diesel-electric locomotives, and electric locomotives, with particular attention to the relative ratings as normally given, the estimated draw bar pull of each, and their relative performances.

Bridgeport: April 15. Bridgeport Engineers Club. Joint Meeting with the Bridgeport Engineers Club. Subject: "Planes for Private Flying," by Prof. Alexander Klemin of New York University, and Everett B. Schaeffer, another authority on this subject.

Central Pennsylvania: April 29. At State College, Pa. In the afternoon Sabin Crocker of the Detroit Edison Company, Detroit, Mich., will address the Student Branch at Pennsylvania State College on the problems encountered in the modernization of the Connors Creek Plant of the Detroit Edison Company. In the evening he will address the members of the Central Pennsylvania Section on the subject of the selection of turbogenerators for Central Stations.

Chicago: April 5. Room 812, 211 West Wacker Drive, Chicago, Ill., at 7:30 p.m. Subject: "National Defense Program."

April 14. Naval Reserve Armory, Chicago, Ill. Chicago Management Council Meeting. Subject: "Industrial Business Planning and Control" (sales analysis and forecasting; balancing equipment, production planning, and control; financial requirements) by Frank C. Everitt, consulting engineer, Stevenson, Jordan & Harrison, Chicago, Ill.

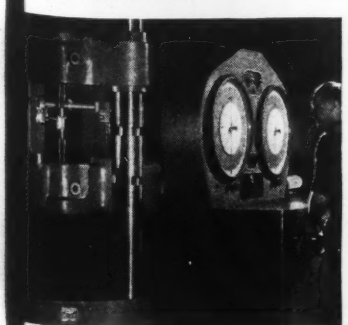
April 26. Room 812, 211 West Wacker Drive, Chicago, Ill. at 7:30 p.m. Subject:

(*Continued on page 366*)

IT'S WHAT'S INSIDE THAT COUNTS!

"FINGERPRINTING" COLD METAL

...0 magnifications . . . flash . . . and a picture ...microscopic examination of a metal is made ...d filed away for future reference on its be...vior. Again a precision instrument of high... quality helps to make certain that what's ...side a Crane valve is exactly what should ...there for greatest service.



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...st sections from raw materials for Crane ...ves tell their tale of tensile strength and ...sticity in this ponderous testing machine. ...ctions are tested to the breaking point, ...hich must be way over specification require... ...nts. What's going inside proves its value here.

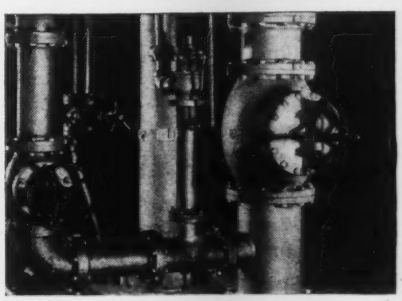
...OVING THEIR CONTROL OVER FLOW

...GHT) All dressed up and ready for the stock ...m, except that they have to withstand the ...king, searching fingers of water, air or ...am under pressures far higher than service ...ngs. Such are the tests that Crane valves ...st pass before being certified for service.

—and that goes for

CRANE VALVES
for Industrial Service

The wrapper may make a cigar look nice. But it takes a high quality, long filler to make it a good smoke. Valves are like good cigars . . . it's what's inside that counts in performance. The more-than-ordinary performance of Crane valves in common use is due to unparalleled experience in designing, uncommon quality of raw materials, unusual care in manufacture, unvarying high standards maintained by the most complete and exacting system of checks and tests of products used in the industry. Install Crane valves and enjoy uncommon valve performance even in valves of common use.



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For three generations of actual service, Crane valves have been proving that they are good all the way through in millions of locations. Only Crane has so vast an accumulated experience in producing valves of known quality, of predictable performance in service.

● If you want uncommon quality in valves of common use, look in the Crane No. 52 Catalog. In its 764 pages there are 38,000 piping items. Quick delivery is assured from a nearby stock. You will find Crane service, like Crane products, good all the way through.

CRANE

CRANE CO., GENERAL OFFICES:
836 SO. MICHIGAN AVENUE, CHICAGO

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

...ATION-WIDE SERVICE THROUGH 134 BRANCHES AND MORE THAN 500 WHOLESALERS

"Aeronautical Transportation," by William Littlewood, chief engineer of the American Airlines.

Erie: April 6. Pennsylvania Telephone Corporation Auditorium, Erie, Pa. Subject: "Electronic Aids in the Elimination of Vibration and Noise," by H. H. Scott, engineer of the General Radio Company, Cambridge, Mass. This talk will be illustrated with lantern slides and motion pictures.

Florida: April 21. The meeting will be held in Jacksonville, Fla. at 2:00 p.m. (with W. E. Drew, of Jacksonville, Fla., in charge of the meeting). Subjects: "Report of the Committee on Mechanical Engineering," by W. A. Lawrence, Florida Power & Light Co., Miami, Fla.; "The Increasing Industrial Significance of the South," by E. W. O'Brien, past vice-president, A.S.M.E., and managing director, *Southern Power Journal*, Atlanta, Ga.; "Pulp and Paper Processes for Southern Pine by D. G. Moon, chief engineer, Union Bag & Paper Corporation, Savannah, Ga.; "Recent Developments in Steam Generation," by Paul R. Yopp, district manager, Babcock and Wilcox Company, Atlanta, Ga.; "Industrial Control Problems," by M. J. McWhorter, district manager, Bailey Meter Company, Atlanta, Ga.; "Economic Possibilities of Reversed Refrigeration for Heating in Florida," by S. P. Goethe, graduate assistant, mechanical-engineering department, University of Florida, Gainesville, Fla.: There will also be a prize paper by a student member, University of Florida Student Branch.

Knoxville: April 24. Club House, Carolina Power & Light Company, Waterville, N. C. at 6:30 p.m. Subject: "The Development and Construction of Waterville Hydraulic Plant," by J. H. Paget manager, development and engineering, Carolina Power & Light Company, Waterville, N. C.

New Britain: April 6. Endee Club, New Departure Manufacturing Co., Bristol, Conn., at 8:00 p.m. Subject: "Engineering Economics," by Ralph E. Flanders, president of the Jones & Lamson Machine Company and past-president of the A.S.M.E.

Norwich: April 15. Allyn Museum, New London. Subject: "Use of Wind Tunnels in Aerodynamic Research," by Dr. William Bolloy, aerodynamician at Harvard University.

Ontario: April 14. Royal York Hotel, Toronto, Ont., Can. Annual Ladies Night. Movies will be shown through the courtesy of the Canadian Pacific Railway. Subject: "Loxology," by Maxwell C. Maxwell, assistant to the president, Yale & Towne Manufacturing Co., New York, N. Y.

Rochester: April 14 or 21. Rochester Engineering Society. Harte Cooke, A.S.M.E. Senior Councilor for Group III, and an authority on Diesel engines, will address the Rochester members.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after April 25, 1938, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Rt = Reinstatement Re = Reelection
Rt & T = Reinstatement and Transfer to Member

NEW APPLICATIONS

For Member, Associate, or Junior

BERGIN, ROBERT F., Detroit, Mich.
BINKERD, ROBERT S., Philadelphia, Pa.
BIOT, MAURICE A., New York, N. Y.
BRETT, JAMES Q., Alameda, Calif.
DICKSON, R. B., Kewanee, Ill.
ENSTROM, AXEL F., Stockholm, Sweden
ERICKSON, H. G., Clear Lake, Iowa
FINEREN, W. W., Gainesville, Fla.
FLIEDNER, A. T., Cleveland, Ohio
FROHLIN, CHARLES R., Palisades Park, N. J.
GAJARSKY, JOHN E., Garfield, N. J.
GANNON, FRANCIS C., Laurelton, L. I., N. Y.
GREEN, TRUMAN JOS., Spur, Texas (Re)
HAMMOND, S. IRVING, Palmerton, Pa. (Rt & T)
HILL, FRED M., Jackson, Mich.
HUGHES, ROBERT H., Spartanburg, S. C. (Re)
HUNTLY, PHIL C., Riverside, Ill.
JORDAN, GEORGE H., Camden, N. J.
KENDALL, THEODORE R., New York, N. Y.
KOCH, ALBERT H., Atlanta, Ga. (Rt)
LEE, GEORGE H., Ithaca, N. Y.
MCGINNIS, C. EDWIN, Los Angeles, Calif.
MCGRAW, J. H., JR., New York, N. Y.
MCKAY, DONALD B., Long Beach, Calif.
MCNAUGHTON, J. B., Chicago, Ill.
MIX, CLARENCE E., Stamford, Conn.
NIEKERK, LEO J., Waterbury, Conn.
OLSON, FOSTER A., Palmerton, Pa.
PLACE, PALMER B., New York, N. Y.
RAINESALO, CHAS. I., Corry, Pa.
RASMUSSEN, STERLING, Oakmont, Pa. (Re)
ROWAN, ROBERT B., Portland, Ore.
SCULLIN, JAMES C., Los Angeles, Calif.
SEARS, MILES F., Davenport, Iowa (Re)
SINGH, CHHUTT-AN., Jamshedpur Via Tatanagar, India
STACY, THOMAS F., Piqua, Ohio
STONE, ERNEST W., Peoria, Ill.
STRAUB, EUGENE D., Syracuse, N. Y.
TIERNEY, JOHN P., Boston, Mass. (Re)
TOTTEN, H. W., Sherman, Texas
TOVE, WILLIAM B., Brooklyn, N. Y. (Rt)
TUCKER, CARROLL C., Worcester, Mass.
VALLELY, L. S., Houston, Texas
VOGEL, HAROLD H., Toledo, Ohio
WILLIAMS, JOHN W., Dallas, Texas
YARYAN, HOMER L., JR., Perrysburg, Ohio

CHANGE OF GRADING

Transfers to Member

ELDERT, JOHN D., Providence, R. I.
JURGELEIT, HERBERT F., Brooklyn, N. Y.
TURNER, FRANK B., Raleigh, N. C.

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

ALEXANDER, WILLIAM, 2ND, February 6, 1938
CLARKE, FRED F., February 8, 1938
FLETCHER, HOWARD C., January 11, 1938
GRISE, ROMEO A., February 4, 1938
ROBB, D. W., February 22, 1938
SCOTT, DUDLEY H., March 4, 1938

A.S.M.E. Transactions for March, 1938

THE March, 1938, issue of the Transactions of the A.S.M.E., which is the *Journal of Applied Mechanics*, contains the following papers:

TECHNICAL PAPERS

Natural Frequencies of Uniform Cantilever Beams of Symmetrical Cross Section, by L. S. Jacobsen
Analysis of Bolted Joints at High Temperature, by E. O. Waters
Effect of Temperature on Physical and Optical Properties of Photoelastic Materials, by G. H. Lee and C. W. Armstrong
Rubber Mountings, by J. F. Downie Smith
A Rapid Method for the Determination of Principal Stresses Across Sections of Symmetry From Photoelastic Data, by M. M. Frocht
Creep of Metals at High Temperature in Bending, by E. A. Davis

DESIGN DATA

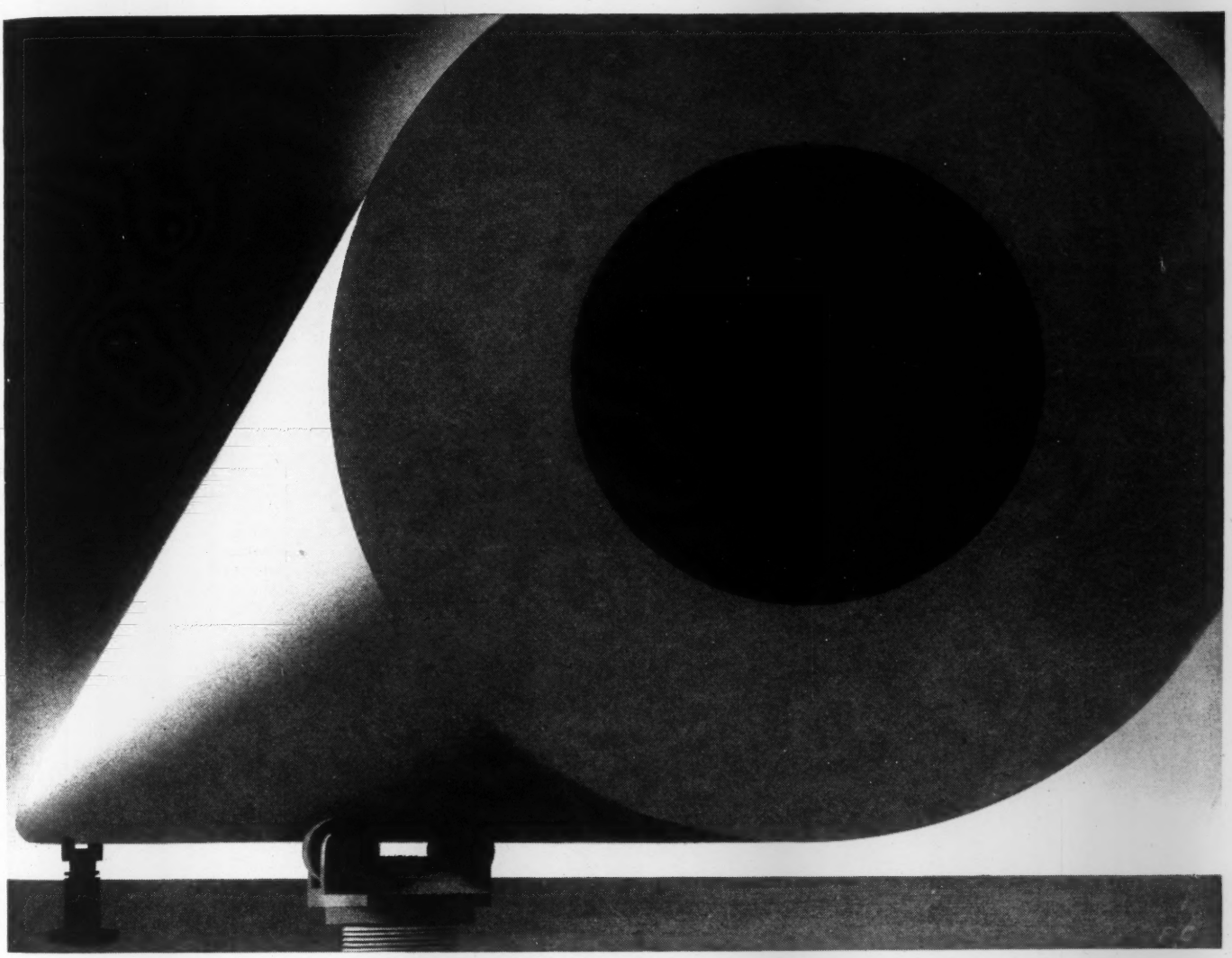
Design of Press- and Shrink-Fitted Assemblies, by O. J. Horger and C. W. Nelson

DISCUSSION

On previously published papers by A. Egli; W. E. Howland; G. B. Karelitz and J. H. Marchant; Joseph Marin; and W. Hovgaard

BOOK REVIEWS

By A. L. Kimball; F. M. Lewis; C. R. Soderberg; C. W. MacGregor; J. Ormondroyd; J. A. Goff; and J. P. Den Hartog



HUGE—YET UNIFORM IN PHYSICAL PROPERTIES

NECESSITY hastens many a discovery. When deep drilling in the oil industry created the need of extra-heavy, extra-durable drill collars, their service requirements and economical construction presented some new machine-shop problems. Among them was the finding of a steel which could be heat treated in long, massive chunks (sometimes 8 tons and 40 to 50 feet long) to produce uniform high physical properties and yet be readily machinable.

Chrome-Molybdenum (SAE 4140) steel proved the solution. It is widely chosen for this purpose because: (a) It develops the requisite physical properties. (b) It responds well to heat treatment—hardening uniformly through the large sections involved. (c) Its machinability at the relatively high hardness is excellent. (d) It is not susceptible to temper brittleness. And—with all its unusual fabricating and service qualities, it is comparatively inexpensive.

Have you heavy-forging problems involving peculiar combinations of service and fabricating requirements? There's a Moly steel, most likely, that's exactly suitable. Investigate. Our free book, "Molybdenum in Steel," will prove helpful. Climax Molybdenum Company, 500 Fifth Avenue, New York City.

PRODUCERS OF FERRO-MOLYBDENUM, CALCIUM MOLYBDATE AND MOLYBDENUM TRIOXIDE

Climax Mo-lyb-den-um Company

MOLY

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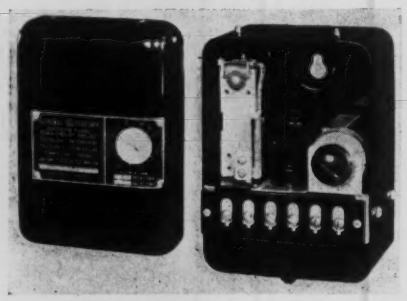
• BUSINESS CHANGES
• LATEST CATALOGS

Announcements from advertisers in MECHANICAL ENGINEERING and the MECHANICAL CATALOG

• NEW EQUIPMENT

New G-E Vacuum-Tube Timer for Machine Applications

A new general-purpose vacuum-tube timer has been announced by General Electric's Industrial Department for application to industrial machinery, particularly machine tools, which require a definite time delay during operation. Of interest to users of such equipment is the fact that the electronic portion of the new device consists of a GE-6C5 three-element, high-vacuum metal tube which not only gives long life to the timer but, in addition, can be easily and inexpensively replaced through any radio supply store when continuous-operating conditions make such replacement necessary.



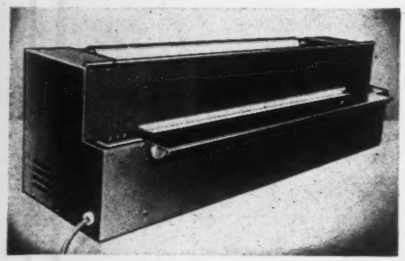
During its developmental stage, the timer was subjected to actual operating tests by several machine-tool manufacturers and it was found that the device was not only reliable in operation but eliminated some of the troubles, such as experienced in the past with mechanical-type timers.

The timer is arranged to operate on either 115 or 230 volts, and 50 or 60 cycles. The contact tips are rated one ampere at 115 volts and 0.5 ampere at 230 volts. It is calibrated with a scale having 10 divisions proportional to time. The maximum and minimum operating times on 115 volts are approximately 60 seconds and three seconds. The resetting time is about five seconds for 100% timing. The timing is reduced to 90% for a resetting time of about one second.

New Printer with Advanced Features

Outgrowth of two years of development and research in Mercury Vapor Tube Printing Equipment, the new Bruning Model 4 Printer for blue prints or Black and White Prints incorporates important improvements, both mechanically and electrically. This new Printer has just been announced by Charles Bruning Co., 100 Reade St., New York, N.Y. The new machine is of the continuous type, the tracings and paper being carried on a heavy, endless canvas band past a curved contact glass, inside of which are mounted two new style, long life mercury vapor tubes, providing the illumination for exposing the print.

The Bruning Model 4 Printer is the only printer offering these new, highly developed Cooper-Hewitt type mercury vapor lamps. Because no resistance is used in the power circuit, these tubes consume 100 watts less current per tube than on the previous Model. Greater light output is also gained since each tube produces 19.5 lumens per watt compared to 14 lumens for the older type. In addition, the type of light produced by this new tube is much more efficient for printing. A printing speed

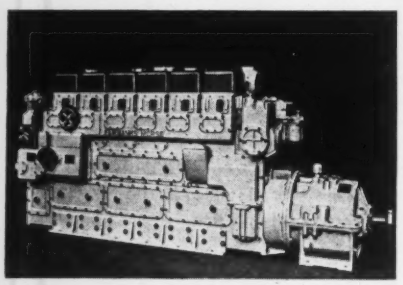


approximately 50% greater than in the previous Model, is gained in the new Model 4 Printer. A positive control of band speed may be had from 2″ per minute minimum to 30″ maximum.

One of the outstanding features of the new machine is the drive to the contact band. All troublesome, noisy, inefficient and unreliable belts, pulleys, friction arrangements, and similar devices have been eliminated, the drive being direct from the motor through a heavy roller chain to the drive roll. Speed is automatically maintained—no periods of inaccurate speed. Ball bearing construction is used throughout the machine, both for motor and rolls. All wiring of the machine is in conduit of approved design, eliminating possibilities of short circuits or danger to the operator. No special wiring required—plugs into lighting circuit. The Model 4 BW Printer is designed for prints up to and including 42″ in width, and any length. The overall size of the machine is 20″ deep, 19″ high, and 61″ long, and is wired for 110 volts A.C. or 110 volts D.C.

New Convertible Gas and Diesel Engine

Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago, Ill., has announced a series of four-cycle, vertical, convertible Diesel and gas engines. This new Model 36-A-8 size



fills a definite need for sturdy, medium-speed engines in the 200 to 300 hp. range. Built in both six- and eight-cylinder combinations, with 8-in. bore and 10½-in. stroke, they develop 35-hp. per cylinder at 720 r.p.m. Smaller sizes of Model 36-A Diesel are available in ratings as low as 8 hp.

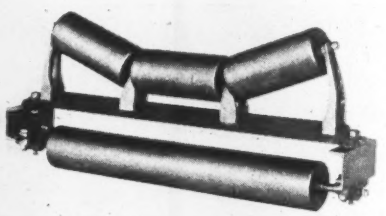
Both Diesel and gas engines in the new 8-in. cylinder size are offered for stationary service, and the Diesels are offered for marine propulsion and in complete, unitbuilt Fairbanks-Morse generating sets as well. The Diesels for marine service are direct-reversible, but can be furnished as non-reversible where such service requires.

The many years of experience of Fairbanks, Morse & Co. in the design and manufacture of Diesel engines for stationary, portable and marine use provide an excellent background for this Model 36-A-8. Designers were guided by the objectives of reliability and economy in service. The resulting engine is extremely simple, neat in appearance, completely self-contained, sturdy and dependable, with excellent fuel and lubricating oil economy.

Enbloc construction is employed, with individual cylinder liners, precision main, connecting-rod and camshaft bearings, and suspended or "underslung" crankshaft. Side cover-plates permit easy accessibility to main and connecting-rod bearings. The design permits double-end drive or power take-off from either end, a distinct advantage in certain types of application.

New Jeffrey Ball-Bearing Belt Idler

A new inexpensive ball-bearing belt idler for carrying moderate loads of semi- and non-abrasive materials is announced by the Jeffrey Manufacturing Co., 904-99 North Fourth Ave., Columbus, Ohio. This idler is of the conventional 3-pulley, 20 deg. troughing type, made for 14, 16, 18, 20, 24, 30, and 36-in. belts. Its ball bearings are of the commercial type, with a cork seal within a pressed steel labyrinth dust cap.



Pulleys are of 4-in. diameter welded steel pipe with formed steel gudgeons welded in the ends. These gudgeons are connected within the pulley by steel tubing which prevents the loss of grease into the pulley proper. Shafts are ⅝-in. seamless tubing and are held by set screws within machine bored holes in the stands. As these shafts are hollow, the entire idler may be lubricated from either end through pressure fittings. Base angles are inverted to shed material.

New Time Study Board

There are many advantages to the new "Meylan" Time Study Board with Stopwatch Holder attached, recently put out by A. R. & J. E. Meylan, 268-70 West 40th Street, New York, N. Y. Since it is made of Bakelite, it is much lighter than wood—it will not warp or crack. It has a smooth highly finished writing surface. Measures 13″ × 10½″ and ¼″ in thickness—net weight 20 oz.

The Stopwatch holder is made of aluminum and is riveted to the board—stopwatch

Continued on Page 18

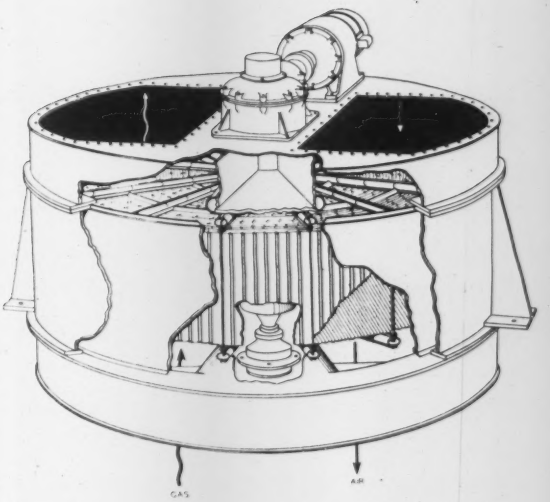
Get the . . .
Highest *Heat Recovery*

with a

Ljungstrom

Air Preheater

The Ljungstrom air preheater employs exclusively the continuous regenerative counterflow principle. This, in combination with the inexpensive, notched undulated heating surface, permits the highest possible heat recoveries at minimum cost.



For the same heat recovery, one inch of Ljungstrom heating surface is approximately equivalent to one foot of plate or tubular heating surface.

Ljungstrom

Other Types

THE AIR PREHEATER CORPORATION

Under the Management of THE SUPERHEATER CO.

60 East 42nd Street New York, N. Y.

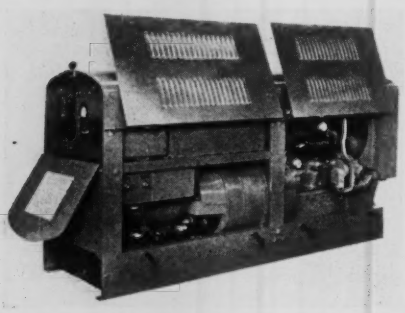
A-1166

Continued from page 16

is guaranteed not to move once the clamp is adjusted—firm, secure and faces user at the proper angle. Watch is wound without removing from holder. Wide movable clip holds data sheets firmly and neatly.

A new 12 page folder No. 4 ME fully illustrates and describes this new time study board, some 40 types of stopwatches, timing instruments, stopwatch stands, etc.

Diesel Engine Driven Arc Welder Announced by Lincoln Electric



A new diesel engine, which differs radically from the popular conception of this type of power in that it compares favorably with gasoline engines in simplicity, weight and cost, as well as operating speed, has been adopted for driving arc welding generators by engineers of The Lincoln Electric Company, Coit Road & Kirby Ave., Cleveland, Ohio, in collaboration with diesel engine manufacturers. Development of this new engine brings the economy of diesel operation to all applications of welding requiring engine driven arc welding generators.

The new diesel driven welder, shown in the accompanying illustration, is the result of extensive research and testing to develop a power plant of correct design and construction to meet requirements of welding service. Built to the specifications of Lincoln engineers, the diesel engine has been operated in the field in severe service and has performed satisfactorily under all conditions.

This new Lincoln welder cuts fuel costs 33% to 86%, depending upon the price of fuel oil used. In many cases, total savings including such items as transportation of fuel, loss, etc. are, therefore, as high as 40c per hour. The engine is an extremely compact unit without extras such as a starter motor, generator, special controls, etc.

The arc welding generator used on the new diesel engine driven welding machine, is the 300-ampere "Shield-Arc SAE" unit equipped with dual-continuous control, a method of welding current control which provides the right size and type of arc for every application of electric welding.

The price of the new diesel engine driven welder compares favorably with that of gasoline engine driven arc welding sets.

New Hays Equipment

The Hays Corporation, Michigan City, Ind., announces two new developments in their line.

The Sequence Control which is of particular interest at this time, owing to the increased use of oil and gas burners and stokers for domestic and small industry use. The control eliminates one of the most annoying things about this type of fuel feed and that is the blow-back that occurs at the point of ignition. Bulletin No. 105 covers this control.

The other is the perfected system of Automatic Combustion Control which was taken over from the Carrick Engineering Company about a year ago and which has undergone considerable development since that time, being almost entirely electrified and simplified to the extent of having all of the instruments and controls mounted on a centralized panel, which is something new in control system design. A forty page catalog has just been issued on this new control system.

• BUSINESS CHANGES

40th Anniversary of the Detroit Stoker

1938 marks the Fortieth Anniversary of the founding of the Detroit Stoker Company, Detroit, Mich. Automatic stokers were almost a curiosity forty years ago. The first Detroit Stoker was built in a modest shop on Atwater Street in Detroit in 1898. Boilers were then wastefully fired by hand. Smoke Abatement Departments in cities were just being established with the idea of eliminating the smoke nuisance. Engineers and firemen had to be educated to the stoker idea. Progress of design and application was slow. Operating difficulties were encountered with the use of the early stoker designs. The industry only survived because of the fortitude and vision of its leaders. Great economy which stokers have brought about in the conservation of fuel is well known. Forty years of effort in the steady and consistent improvement of Detroit Stokers has developed a complete line of Detroit Stokers to meet every modern need. In many instances efficiencies can be raised to new standards, capacities of present boilers increased and larger return shown on investment with modern stoker equipment.

New Terry Turbine Representative

The Terry Steam Turbine Co., Hartford, Conn., announces the appointment of R. E. Chase & Company, Tacoma Building, Tacoma, Washington, with branch offices in Seattle, Portland and Spokane, as a representative of The Terry Steam Turbine Co.

G-E Safety Record

Safety records for 1937 compiled by the General Electric Company, Schenectady, N.Y., show that the frequency of accidents—the number of lost time accidents per million hours worked—was lower than at any previous time in the history of the company. For the year the mark was 6.49. The best previous year was 1936, when the figure

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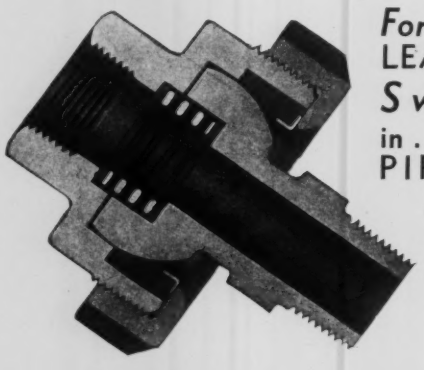
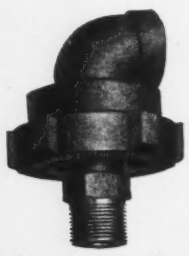
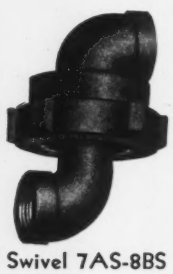


For LEAK PROOF *Swing* in . . . PIPE LINES

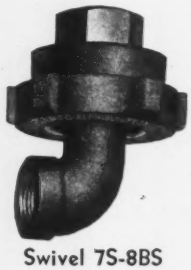
BARCO SWIVEL JOINTS



Swivel 7AS-8CS



Swivel 7AS-8BS



Swivel 7S-8BS

These master BARCO joints permit full 360-degree swivel movement with no tendency to bind where slight irregularities are encountered. They are spring seated with stainless steel springs and do not leak under rapid temperature variation. They are equally fluid-tight under suction or pressure. Gaskets cannot blow out . . . assuring exceptional life and low maintenance cost. Convincing evidence of their dependability is found in their adoption as standard equipment by many leading manufacturers of platen pressses, tube molds, flap molds, heel presses, rubber rolls, vulcanizing heaters, Bakelite presses, etc.

Catalog 256 will give you complete details.

BARCO MANUFACTURING CO.

1811 Winnemac Ave., CHICAGO, ILL.

Two new Union Pacific

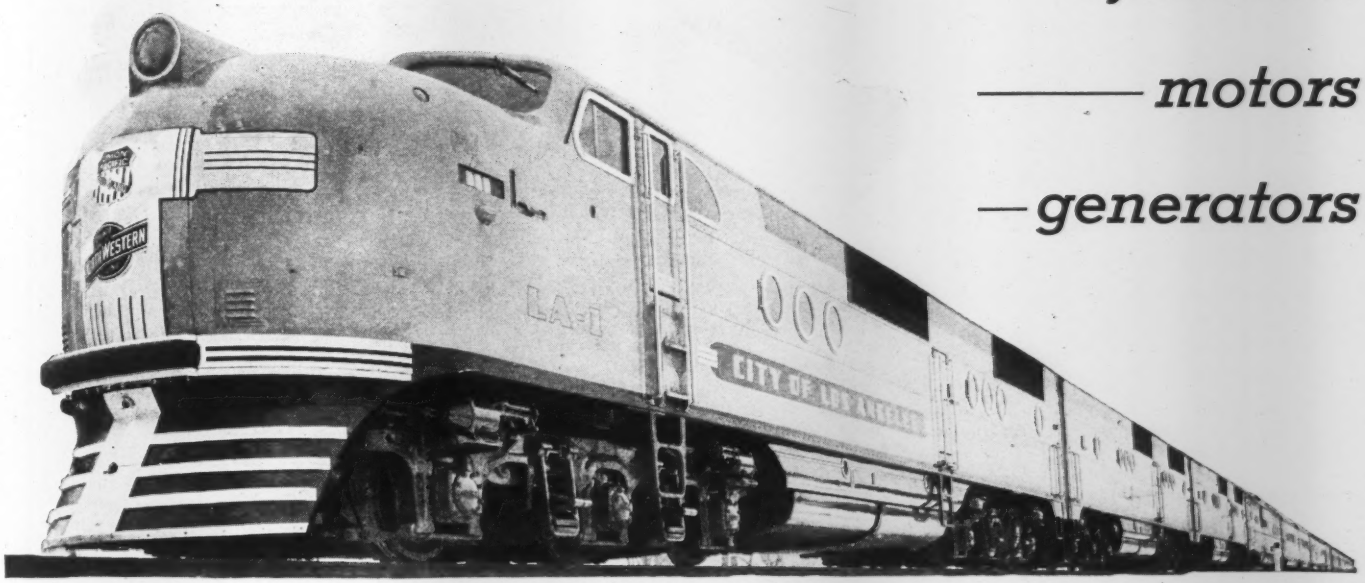
17-CAR TRAINS

are **SKF**-*equipped on*

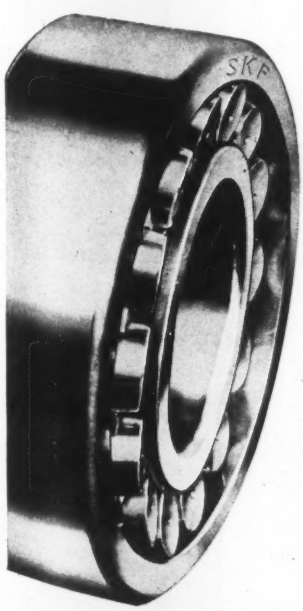
——journals

——motors

—generators



● *Built by Electro-Motive Corp. and The Pullman-Standard Car Mfg. Co., the "City of Los Angeles, 2nd" is owned and operated by the Union Pacific and the Chicago & North Western and the "City of San Francisco, 2nd" is owned and operated by the Union Pacific, the Chicago & North Western and the Southern Pacific.*



ONCE AGAIN the Union Pacific Railroad uses SKF Journal Bearings on crack streamliners, for SKF's are on the "City of Los Angeles, 2nd" and "City of San Francisco, 2nd". And they are giving the same dependability that characterizes the use of SKF's on the "Cities of Salina, Portland, Los Angeles and Denver".

Railroads *depend* on SKF Journal Bearings for long runs, low operating costs per mile, and greater availability of equipment. That is why in 1937 alone SKF delivered more than 8000 journal bearings on American railroads. Over 250,000 journal bearings are in service on the Class 1 railroads of the world. SKF always puts the right bearing in the right place.

4038

SKF INDUSTRIES, INC., FRONT ST. & ERIE AVE., PHILA., PA.

SKF

BALL AND ROLLER BEARINGS

BIG NEWS

MARS LUMOGRAPH Pencils

Make BETTER Direct REPRODUCTIONS

Elimination of time-taking inking in is now more practical then ever before—Mars LUMOGRAPH Pencils insure more perfect reproductions—save time, labor, money.

The reason: Mars LUMOGRAPH lead contains a special, patented light resisting element that produces a very opaque line, impervious to the light of reproducing equipment—resulting in clean, clear blue prints or black and whites.

Add to this exclusive LUMOGRAPH feature the uniformity, accurate grading, thorough-going quality of LUMOGRAPH and you will see why it is the preferred drawing pencil in hundreds of drafting rooms.

Mars Lumograph Pencils

Obtainable in Three Types

No. 2886—Made of finest Southern Cedar, finished in blue with black tip, with degree of hardness marked in gold at top of pencil on all six sides. 17 degrees of hardness.....15c ea.

No. 2888—"Chisel Point" oval shape with flat lead makes possible extremely long lines of uniform thickness. This unique construction offers the advantage of an unusually thin lead with no risk of breakage. Same wood and finish as No. 2886 with degrees of hardness marked in gold on the two sides. In 6 hard degrees.....15c ea.

No. 1018—Artist Pencil with lead sharpener at end. Made to hold No. 1904 Mars Lumograph leads. Refillable from the top. Special finger grip makes this pencil extremely easy to use..50c ea.

No. 1904—Mars Lumograph Refill Leads for No. 1018 Artist Pencil. Same as in No. 2886 Mars Lumograph Pencil. 13 degrees of hardness. Box of 6 leads.....50c a box

Convince yourself of the merits of this unique pencil—make your own practical test.

MAIL COUPON TODAY

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53-55 Worth St., New York

Gentlemen—Enclosed find $.....
Please send postpaid—Mars Lumograph Pencils or leads as checked.

Quantity	Number	Degree

Name .....
Street.....
City.....State.....
My Dealer's Name is.....

• Keep Informed

Continued from page 18

stood at 6.60. Likewise, the severity rate, which accounts for days lost per thousand hours worked, shrank to .524 from the previous low of .567 in 1935.

In December, 22 of 33 General Electric and associated plants were without a single accident. Several plants had perfect records of even more than one month.

Morse Chain Sales Changes

Walter W. Bertram, Sales Manager of Morse Chain Company, Ithaca, New York, announces the following changes in the sales organization. Arthur F. Weston becomes Manager of the Chicago office. Mr. Weston was formerly in charge of the Cincinnati office. Wm. C. Gilbert, formerly of the Detroit office, has been transferred to Chicago. C. A. Shetter, formerly Manager of the Cleveland office becomes Manager of the Cincinnati branch. Lon Sloan, formerly Special Development Engineer at Chicago, becomes Manager of the Cleveland office.

New Cincinnati Representative for Ludlum Steel

Ludlum Steel Co., 350 Armstrong Street, Watervliet, N. Y., has appointed Gerald D. Howk as its mill representative in the Cincinnati territory. His headquarters will be in the offices of Julius Uihlein & Co., 208 Elm Street, Cincinnati. Mr. Howk, who is thoroughly familiar with the heat treating and other technical phases of all Ludlum fine steels, will assist the Uihlein Company in servicing the Ludlum products regularly handled by them. He will also represent Ludlum on products not now covered by the Uihlein arrangements.

• LATEST CATALOGS

Springs and Wire Forms

An interesting new booklet is offered by Hunter Pressed Steel Company, Lansdale, Pa., regarding their designing and production facilities for springs of all types, sizes and metals. The booklet explains their special services, shows some views of their plant and testing facilities and a brief resumé of their experience. A copy will be sent to anyone interested.

Johnson Friction Clutches

The Carlyle Johnson Machine Co., Manchester, Conn., announce their new 1938 clutch catalog, descriptive of "Johnson Friction Clutches."

Their standard type of Friction Clutch with metal to metal frictions, as well as our Super-Johnson Type with Raybestos faced expansion ring, the latter to run dry where such a method of driving is required, are both listed in this new issue. All recent improvements are also listed and several changes in price.

DeLaval Pumping Equipment

The new East Park Pumping Station of the City of Philadelphia is described and illustrated in a leaflet distributed by the De Laval Steam Turbine Co., Trenton, N. J., builders of the pumping equipment. This new Station is located alongside a 48-inch cast iron main feeding into the main section of Philadelphia and was designed to improve the conditions in the large downtown or central section of the city, to supply the

Continued on Page 22

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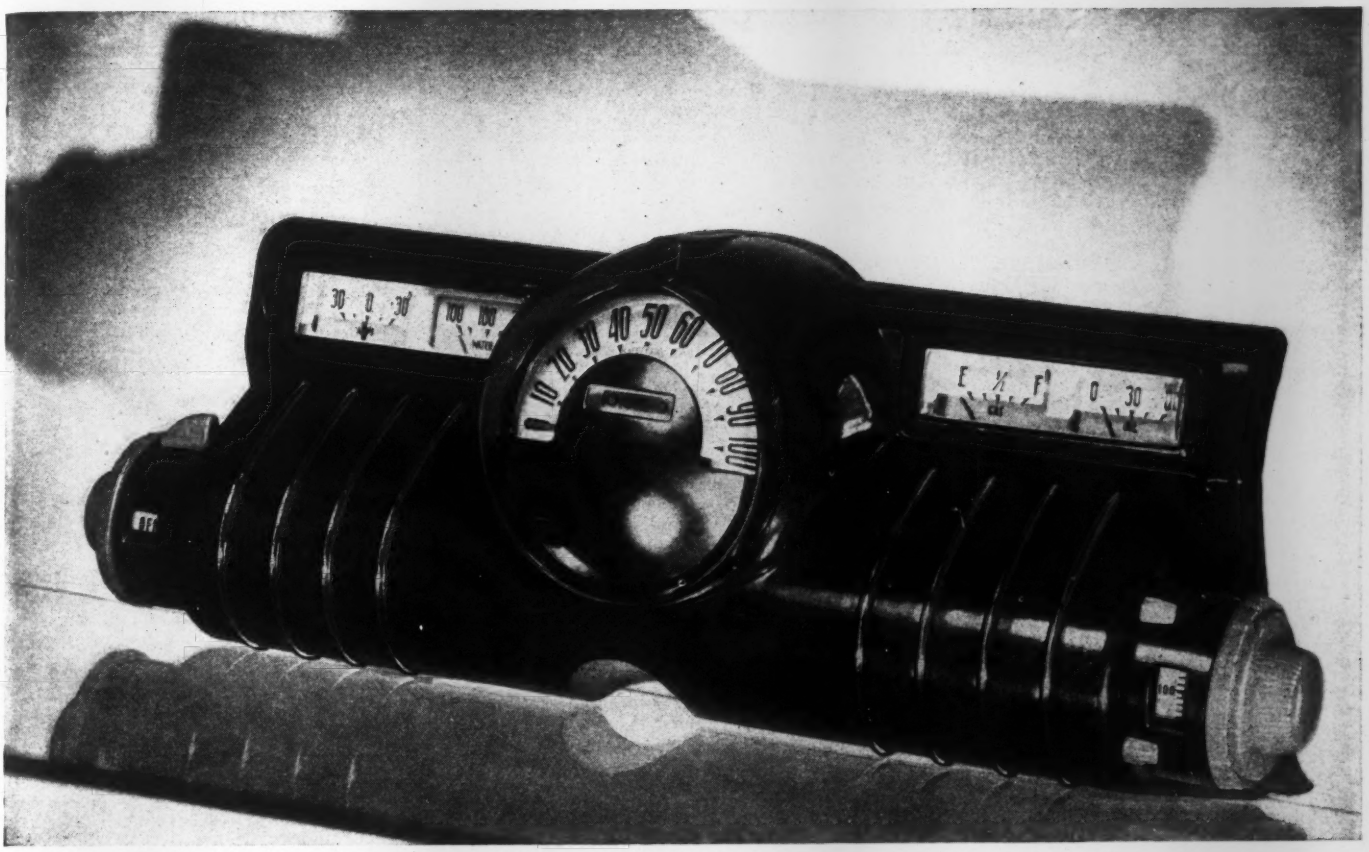
RATE Announcements under this heading in MECHANICAL ENGINEERING are inserted at the flat rate of $1.25 a line per issue, $1.00 a line to A.S.M.E. members. Minimum charge, three line basis. Uniform style set-up. Copy must be in hand not later than the 10th of the month preceding date of publication.



Bakelite Molded Safety Instrument Unit for 1938 Oldsmobile, measuring 15⅝" x 7½" x 6⅛". Completed in one press operation. Molder: Reynolds Molded Plastics

Motorcar Style and Safety
advanced by Bakelite Molded

MOST RECENT of the many contributions made by Bakelite materials to the styling and dependability of modern automobiles, is the new Safety Instrument Unit of the 1938 Oldsmobile.

Formed in a single, rugged piece from Impact Bakelite Molded, this unit permits compact grouping of all instruments and radio controls in a decorative assembly situated directly before the driver's eyes.

Selection of Bakelite Molded was determined by numerous combined advantages of the material, including: durability, high weight-strength factor, electrical insulation value, ready adaptability to decorative form and treatment, and high resistance to moisture, oil and wear.

These same, and additional, merits of Bakelite Molded offer unlimited opportunities for improvements in the design and manufacture of products in nearly every branch of industry and commerce. We invite manufacturers, designers and molders to acquaint themselves with the many different types of this material available for varied purposes.

Write for reference booklet 32M, "Bakelite Molded." Also consult us for specific recommendations.

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BAKELITE CORPORATION OF CANADA, LIMITED, 163 Dufferin Street, Toronto, Canada *West Coast:* Electrical Specialty Co., Inc., 316 Eleventh Street, San Francisco, Cal.

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PLASTICS HEADQUARTERS

Continued from page 20

excess demand of South Philadelphia in extremely hot periods, and to act as a standby to supply the West Philadelphia area in case of trouble at the Belmont Pumping Station. The three pumping units are driven by synchronous motors and are each designed to deliver 25 million gallons per day against 149 ft. head, or 20 million gallons per day against 170 ft. head. Actual test after installation showed an efficiency from wire to water exceeding 85 per cent, and one of the pumps, delivering at the rate of 25.01 m.g.d. from 13.4 ft. suction head to 157.9 ft. discharge head, showed 90.8 per cent pump efficiency.

New Bristol Co. Bulletin

The various improvements recently made in Bristol's Recording Voltmeters and Ammeters are outlined in a new bulletin now available through the main office of The Bristol Company, 21 Bridge Street, Waterbury, Conn. Sample chart records and photographs of the new instrument models, showing the compact and simple operating mechanism, are included in the bulletin. Interesting facts are also given regarding the usefulness and the various applications of these instruments in such industries as: public utilities, chemical, ceramics, rubber and plastics, pulp and paper, food, and dairy. A copy of Bulletin No. 496 on Bristol's Modern Electric Recorders, may be obtained upon request.

Lift Plug Valves

Homestead Valve Mfg. Co., P. O. Box 82, Coraopolis, Pa., announces a new piece of literature on Homestead Lift-Plug Valves, the advantages of which have been condensed so that they may be quickly grasped by anyone who is interested in a type of valve which will solve valve operating difficulties experienced under the more severe pressure and temperature service conditions. A glance at the first inside fold under the heading of "Typical Uses for Homestead Lift-Plug Valves" will quickly show you just how many applications there are for this type of valve in your particular industry as represented by your readers.

Rotary Positive Blowers

Roots-Connerville Blower Co., Connersville, Ind., announces a new bulletin 21-B-19 which discusses more completely the characteristic positive movement of air by their Victor-Acme Rotary Positive Blowers, than previous editions. Covering normal capacities ranging up to 500 CFM at pressures up to 7 or 8 lbs., or equivalent vacuums, these blowers are used in a variety of processes and applied to many special machines, where the handling of definite volumes of clean dry air is necessary.

The many standard sizes listed in this bulletin permit the economical selection of one that will meet the specified requirements of the different services, some of which are illustrated, while others are listed.

Hancock Bronze Valve Bulletin

It describes and illustrates Hancock's complete line of bronze valves. Particularly featured is the line of Hancock "500 Brinell" supervalves with the nail-smashing hardened stainless steel seats and discs. Copies will be furnished on request by Hancock Valve Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.

G-E New Instrument Bulletin

Bringing together instrumentation and machinery for the betterment of industry is the primary purpose of a new house organ entitled "Instruments in Industry," which will be issued periodically by the Meter Division of the General Electric Co., Schenectady, N. Y. The many ways in which electric instruments can bring more and greater benefits to industry are presented and illustrated, and new products are announced in the columns of this periodical.

Emergency testing, making plant surveys, testing new equipment, controlling production, and incorporation in the product itself are a few instrument uses in the industrial field. Likewise utilities and transportation companies are finding instruments invaluable in giving customer service. This publication, printed in small newspaper form, is distributed free of charge to industrial plants.

A Complete Assembly Service for Electrical and Other Manufacturers

An interesting folder is offered by Hunter Pressed Steel Company at Lansdale, Pa., regarding their unusual facilities to assist electrical and other manufacturers on assembly work. This firm's designing, machining, testing and assembly facilities have been of great value to many manufacturers. The bulletin briefly tells how and why such firms can save time, money and trouble. A copy of the booklet will be gladly sent upon request.

COMING MEETINGS AND EXPOSITIONS

For the next three months

APRIL

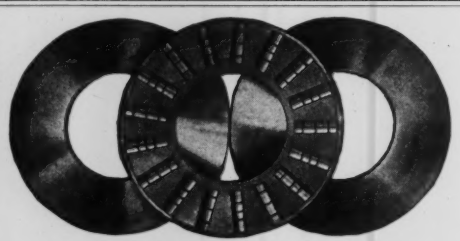
13–15	Midwest Power Conference, La-Salle Hotel, Chicago, Illinois.
Wk. of 17	American Society of Civil Engineers, Spring Meeting, Jacksonville, Fla.
18–19 20	American Gear Manufacturers Association, 22nd Annual Meeting, General Brock Hotel, Niagara Falls, Canada.
22–23	Society for the Advancement of Management, Spring Meeting, Boston, Mass.
Wk. of 24	American Water Works Association, Annual Convention, New Orleans, La.
28–29	Association of Iron and Steel Engineers, Annual Spring Conference, Baltimore, Md.

MAY

9–11	American Institute of Chemical Engineers, Semi-Annual Meeting, Greenbrier Hotel, White Sulphur Springs, West Virginia.
14–21	Tenth International Petroleum Exposition, Tulsa, Oklahoma.
Wk. of 14	American Foundrymen's Association, Annual Convention and Exhibit, Cleveland, Ohio.
17	Society of Naval Architects and Marine Engineers, Spring Meeting, Washington, D. C.
23–25	American Petroleum Institute, Mid-Year Meeting, Wichita, Kansas.
26	American Iron & Steel Institute, General Meeting, Waldorf-Astoria Hotel, New York, N. Y.

June

12–17	Society of Automotive Engineers, Summer Meeting, The Greenbrier, White Sulphur Springs, W. Va.
20–24	American Institute of Electrical Engineers, Annual Summer Convention, Washington, D. C.
20–22	American Society of Heating & Ventilating Engineers, Semi-Annual Meeting, The Homestead, Hot Springs, Va.
20–24	American Society of Refrigerating Engineers, Spring Meeting, State College, Pa.
Wk. of 20	American Society of Mechanical Engineers, Semi-Annual Meeting, St. Louis, Mo.
27–July 1	American Association for the Advancement of Science, Summer Meeting, Ottawa, Canada.
27–July 1	American Society for Testing Materials, Annual Meeting, Atlantic City, N. J.
29–30	Institute of the Aeronautical Sciences, Inc., Technical Meeting, Ottawa, Canada.



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